

## **Section 4. Description and Assessment of the Current Status of Aquatic Habitat and Covered Species in the Area Where the Plan Will Be Implemented**

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### **4.1 INTRODUCTION**

This Section summarizes what is known about the current status of aquatic habitat and Covered Species in the area where the Plan will be implemented (including the area where incidental take will be authorized). It presents information about the HPAs as a whole, the Eligible Plan Area within the HPAs (i.e., Initial Plan Area and Adjustment Area), and assessments conducted on Green Diamond's ownership. (The area where assessments were conducted is cited as the "Original Assessed Ownership"; this area excludes lands that, as anticipated in the draft Plan, were acquired by Green Diamond prior to the effective date of the Permits). Factors and conditions relevant to the planning and implementation of conservation measures for the Covered Species are identified and examined in three subsections.

- Geologic and Geomorphic Factors (Section 4.2) presents the underlying physical characteristics of the watersheds and watercourses in the 11 HPAs and identifies the contribution of those characteristics to habitat conditions. Characteristics unique to an HPA or Green Diamond's ownership also are noted.
- Methods and Results of Studies in the Original Assessed Ownership (Section 4.3) summarizes the data collection and assessments that were conducted to determine habitat conditions and the status of Covered Species on the Original Assessed Ownership and provide a basis for analyzing other commercial timberlands in the Eligible Plan Area.
- Assessment of Habitat Conditions and Status of Covered Species by HPA (Section 4.4) describes the characteristics of each HPA; identifies similarities and differences in habitat conditions and occurrence of Covered Species within and among HPAs; and identifies specific conservation concerns for Covered Species in each HPA.

### **4.2 GEOLOGIC AND GEOMORPHIC FACTORS**

North coastal California includes some of the most rapidly eroding areas in the United States. Streams draining the area, such as the Eel River, have some of the highest suspended sediment loads per unit area recorded in the world (Judson and Ritter 1964). One fundamental reason for this occurrence is the unstable geology of the Coast Range (CA DWR 1992). A basic knowledge of the geology and geomorphology of the region is

essential to understanding the environmental condition of the area. The following text provides a description of the geology and geomorphology in the HPAs. The information provides a broad overview of how geologic characteristics such as bedrock composition, bedrock structure, and tectonic uplift relate to topography, mass wasting, and erosion in the region.

#### **4.2.1 Geologic Composition, Structure, and Activity**

As shown in **Figure 4-1 (A-D)**, the HPAs are located mostly within California's Coast Ranges geologic province. At their northeastern margin, they are within the Klamath Mountains geologic province. Both provinces include a complex of terranes that collectively are within the convergent margin of the North American plate. Within the individual provinces and terranes, geomorphic conditions vary widely. On a regional scale, the bedrock in the HPAs is a composite of accreted oceanic rocks and pre- and post-accretionary plutonic rocks that are overlain in places by younger depositional strata. Locally, the bedrock can vary greatly, ranging from deeply weathered sandstone and mudstone to metasedimentary rock, greenstone, and ultramafic bedrock.

The geologic structure of the HPAs generally is dominated by a series of north to northwest trending faults. The faults correspond to topographic highs (such as the South Fork Mountain Fault) and lows (such as the Grogan Fault). Numerous northwest-trending anticlines and synclines are associated with the faulting and also contribute to the shape of the landscape. The extensive uplift of the region is well known. The height of the mountains and the high elevation of bedrock composed of marine sediments and ultramafic ophiolite sequences are the most obvious indicators of this uplift. Accretion, deformation, and uplift of the region are ongoing today, as interactions continue between the Gorda, Pacific, and North American tectonic plates along the continental margin. Slip rates along the major thrust faults in the area is on the order of several millimeters per year (California Department of Conservation, Division of Mines and Geology (DMG)).

##### **4.2.1.1 Klamath Mountain Province**

At present, five major terranes of the Klamath Mountains are recognized, and several of these are subdivided into two or more geologic units. Each terrane is bordered by major faults that represent lines or sutures where plate fragments are joined (Harden 1998).

###### **4.2.1.1.1 Western Jurassic Belt**

The rocks of the Western Jurassic Belt underlie the eastern margin of the HPAs. This belt represents the youngest accreted terranes within the Klamath province. This belt includes the rock units of the Smith River subterrane (Galice Formation) as well as rocks that may be correlative with the Josephine Ophiolite.

The Galice Formation represents a long belt of metasedimentary rocks formed during the Jurassic period approximately 150 million years ago. The rocks of the Galice formation include marine slate (mildly slaty to phyllitic argillite), partially serpentinized peridotite, metagraywacke, stretched pebble conglomerate, greenstone, and metavolcanic Western Jurassic Belt breccia.

The Josephine Ophiolite represents a remnant of oceanic basement rocks that originated from a fragment of oceanic plate that was thrust onto the North American continent during the Jurassic period. The rocks of the Josephine Ophiolite include gabbro, pyroxinite, pillow basalt, serpentinite, and sequences of ultramafic rocks.

The Western Jurassic Belt also contains small pockets of intruded dioritic rocks that may occur in the Original Assessed Ownership and elsewhere in the HPAs. To the west, the rocks of the western Jurassic belt are separated from the rocks of the Coast Ranges by a major fault (the South Fork Mountain Thrust fault).

#### **4.2.1.1.2 Western Paleozoic and Triassic Belt**

This belt is located to the east of the Western Jurassic belt and has been subdivided into at least three separate geologic terranes. Only one terrane (Rattlesnake Creek) occurs within the HPAs.

The Rattlesnake Creek terrane includes oceanic ultramafic rocks (i.e., gabbro), metasedimentary rocks (i.e., argillite, phyllite, conglomerate and metachert), volcanoclastic sediments, and mixed volcanic and metasedimentary rocks. In addition, the Western Paleozoic and Triassic belt contains extensive intrusions of post-accretionary dioritic and pre-accretionary ultramafic-gabbroic plutonic rocks. However, it is uncertain if any of these materials occur within the Original Assessed Ownership or elsewhere in the HPAs. The Western Paleozoic and Triassic belt is primarily located along the eastern margin of the Smith River HPA and is separated from the Western Jurassic Belt by a complex network of thrust faults.

#### **4.2.1.2 Coast Range Province**

As noted, the HPAs are located mostly within the Coast Range Province (see **Figure 4.1**). The rocks of the Coast Range represent oceanic crust that was accreted to the continent beginning in the mid-Jurassic period (approximately 140 million years ago). Similar to the Klamath Province, the assemblages of the Coast Range terranes are fault bounded and exhibit a sequential east to west accretionary pattern.

##### **4.2.1.2.1 Franciscan Complex**

The Franciscan Complex includes three major belts: the Eastern, Central, and Coastal belts. Cashman et al. 1995 and McLaughlin et al. 2000 describe the rocks of these belts and the geologic terranes in further detail. In general, the most abundant types of rock units found within these terranes consist of layered and interlayered sequences of marine sandstone (i.e., greywacke sandstone), mudstone, and other common rock types such as schist, melange, serpentinite, chert, and conglomerate, basalt, and Coast Range ophiolitic rocks. Because the Franciscan Complex rock units vary greatly in lithology, structural style, and degree of metamorphism, the rocks in the complex are also described as belonging to a specific textural zone (Blake et al. 1967). It should be noted that some of the older geologic maps used to compile **Figure 4-1** did not differentiate the various units and textural zones. Thus, unless a unit is specifically called out on the map, the textural zones listed below may be included in the areas mapped as Franciscan Complex (KJf) and Franciscan Complex Sandstone (KJfss). The textural zones of the Franciscan Complex include the following:

- Franciscan Melange. The Franciscan Melange consists of discontinuous, resistant blocks of graywacke sandstone, chert, greenstone, and high-grade metamorphic rock in an intensely sheared, blue-gray shaley matrix. The texture of the unit may be related to mixing by either tectonic or sedimentary (mudslide) processes (Jordan 1978).
- Unmetamorphosed Franciscan Complex - Textural Zone 1. Textural Zone 1 consists of fine- to coarse-grained graywacke sandstone with interbeds of siltstone, shale and minor conglomerate. The rocks are olive to gray-green when fresh and weather to tan or gray-brown. Exposures are well-lithified and massive to thickly bedded. Subordinate rock types include chert, pillow basalt, and greenstone.
- Semi-Metamorphosed Franciscan Complex - Textural Zone 2. Textural Zone 2 consists of semi-schistose, lawsonite bearing graywacke sandstone and siltstone, similar to the rocks in Textural Zone 1. Platy foliation, visible in hand specimen, has developed, but original bedding is still present.
- Undifferentiated Franciscan Complex. Undifferentiated Franciscan Complex is mapped where the Franciscan has not been subdivided. It consists predominantly of fine- to coarse-grained dark gray to green graywacke sandstone and dark-gray shale. Subordinate amounts of red or green chert, conglomerate, pillow basalt, greenstone, and pods of serpentinized ultramafic rocks also occur within this unit.
- South Fork Mountain Schist - Textural Zone 3. The South Fork Mountain Schist is metamorphosed and sheared to the point where original bedding is no longer evident. The unit forms a sinuous belt of schistose metasedimentary and metavolcanic rocks next to the South Fork Fault, the unit's eastern boundary.

#### 4.2.1.2 Overlap Assemblage

Sedimentary deposits that formed in a variety of marine to non-marine environments overlie the late Cenozoic to late Mesozoic accreted terranes of the Franciscan Complex. These deposits (the Late Cenozoic post-accretionary Overlap Assemblage) are partly similar in age to the Franciscan basement rocks. However, the rocks are considerably less deformed, unmetamorphosed, and less lithified than the rocks of the Franciscan Complex (McLaughlin et al. 2000). The primary rock units that occur in the overlap assemblage are represented by the formations of the Wildcat Group and to a lesser extent the Bear River beds. In general, the Wildcat Group consists predominantly of a sequence of weakly to moderately well lithified marine sandstone, siltstone, mudstone, and non-marine sandstones and conglomerates. The Wildcat Group overlies older basement rocks of the Franciscan Complex and middle rocks that have been assigned to the Bear River beds (interbedded siltstone, sandstone) (McLaughlin et al. 2000).

#### **4.2.1.3 Other Quaternary and Tertiary Overlap Deposits**

Some rocks may occur within both the Klamath and Coast Range provinces. These rocks include units of unconsolidated or weakly consolidated materials such as terrace deposits, alluvial and colluvial materials, coastal sediments, and unusual occurrences of post-accretionary intrusive rocks (e.g., Coyote Peak diatreme).

#### 4.2.1.3.1 Weathered Bedrock, Colluvium, and Soils

An overlying mantle of weathered bedrock and colluvial deposits is ubiquitous in the HPAs. Typically, the deposits are poorly consolidated, loose and moderately to well drained. The material is usually thickest toward the axes of swales and drainages and thinnest on the steeper side slopes where it has been shed off by erosion and shallow landsliding. The composition and thickness of the colluvial deposits and associated soils is variable and is related to the makeup and slope gradient of the underlying bedrock.

Thicker colluvium and soils typically reside in areas with gentle slopes where the bedrock is usually less indurated. Steeper slopes are generally covered by only a thin mantle (typically less than three feet thick) of colluvium. These slopes are usually underlain by hard, well-cemented materials (e.g., sandstone, siltstone), and the contact between the bedrock and colluvium is often sharp. The sharp contact is often accompanied by a permeability contrast between the two units that allows a seasonal perched water table to develop. The thin soil cover is a product of the inherent low rate of bedrock weathering and the steepness of the slope (which facilitates the shedding off of the unconsolidated surface material). The thin nature of the colluvial deposits overlying hard bedrock on the steeper slopes plays an important role in the style and distribution of shallow landslides and the potential effects of timber management.

#### 4.2.1.3.2 Modern Alluvium

Scattered concentrations of modern alluvium occur along stream beds and inner and upper floodplains. The alluvial materials include boulders in creek bottoms, sand, pebbles, and cobbly gravel in inner floodplains and fine sand and silt loam in overbank deposits.

#### 4.2.1.3.3 Stream Terrace Deposits

Deposits of moderately to intensely weathered alluvium are scattered throughout the HPAs. Mapable units have been noted in prominent terrace surfaces adjacent to Redwood Creek, and remnants of former terrace deposits have been mapped on gently sloping hillslopes near Redwood Creek (Harden et al. 1982). Late Quaternary fluvial terraces are found along well developed major rivers such as the Mad, Eel, and Van Duzen rivers.

#### 4.2.1.3.4 Coastal Plain Sediments

Unconsolidated to weakly consolidated silts, sands, and gravels associated with minor amounts of organic-rich mud are located along the coastal plain.

#### 4.2.1.3.5 Landslide Deposits

A number of landslide deposits and scars have been mapped within the Original Assessed Ownership and elsewhere in the HPAs (Harden et al. 1982). Many of the more prominent landslides may be correlated to terranes underlain by fault zones and specific rock units (e.g., the Incoherent Unit of Coyote Creek in the Franciscan Complex).

#### **4.2.1.3.6 Tertiary Intrusive Rocks**

The Central belt of the Franciscan Complex contains limited occurrences of (alkalic) intrusive volcanic rocks of unusual mineralogical composition. These intrusive bodies correspond in age to the Oligocene epoch (approximately 35 million years before) and occur at two localities northeast of Arcata. One of these localities, known as the Coyote Peak diatreme, is located within the Redwood Creek HPA.

#### **4.2.1.4 Seismic Hazards, Faults, and Structural Relationships**

Northern coastal California and the adjacent offshore area constitute one of the most seismically active areas in the State (Cashman et al. 1995). This entire area of northwest coastal California is subject to high hazard from potential earthquakes on several onshore faults and the region falls within the Cascadia subduction zone, an area thought to be capable of great (magnitude 8 to 9) earthquakes (CA DMG 1996). The high level of tectonic activity in the region is also attributed to the proximity of the Mendocino triple junction (McKenzie and Morgan 1969), located south of the planning area which separates three major crustal plates and is the northern terminus of the San Andreas Fault (see **Figure 4-1**).

Several moderately active crustal faults (e.g., the Little Salmon, Mad River, Trinidad, and Fickle Hill faults) are located near or within sections of the Original Assessed Ownership. Faults that show evidence of recent (Quaternary) movement and faults that form the boundaries separating the major belts, terranes, and sub-terrane of the Klamath Mountains and Coast Range provinces are described below. Although most of these faults strike northwest, they exhibit a range of orientations from shallowly dipping to vertical and also represent different deformational episodes (Monsen, Alto, Cashman et al. 1980, 1982). In addition, the orientations of the region's faults and geologic terranes often mark contacts between distinctly different rock units that in-turn, strongly influence area topography and drainage patterns. The faults that exhibit evidence of recent activity may also delineate potential geologic hazard zones (i.e., the occurrence of high ground accelerations resulting from earthquakes on nearby faults may directly or indirectly result in slope failures).

The following faults exhibit evidence of recent movement and may be active:

- **Patricks Point Fault.** The Patricks Point fault is a northeast-dipping thrust fault located below the prominent raised marine terrace cut into the Falor and Franciscan rocks at Patricks Point. The terraces are interpreted to record fault bend folding of the hanging wall of a deeply buried, thrust above the fault. The length of the inclined segment of the Patricks Point terrace is about 2 kilometers (km). The fault bend fold model predicts this length should correspond with the total accrued slip on the buried fault, i.e., about 2.4 centimeters per year (Carver and Burke 1989).
- **Mad River Fault Zone.** The Mad River fault zone is a major zone of complex southwest verging thrust faults located in the vicinity of the Mad River northeast of Arcata Bay. There are five principle faults in the Mad River Fault zone including the Trinidad, Blue Lake, McKinleyville, Mad River, Fickle Hill, and numerous minor thrustfaults (e.g., Korbel and Falor faults). The faults of this zone have been shown to displace strata in the late Pleistocene to Holocene age (< 2 million years) and are thus active (McLaughlin et al. 2000).

- Freshwater Fault. The Freshwater fault is an east dipping, high angle reverse fault, which decreases in dip to the north. Movement on this fault was thought to have preceded Wildcat deposition (Ogle 1953), but recent studies show it to offset the Wildcat, suggesting late Cenozoic reactivation (Woodward-Clyde Consultants 1980).
- Little Salmon Creek and Yager Faults. The Little Salmon Creek fault a moderately low dipping southwest thrust fault zone located in the central Eel River basin south of Eureka. The fault zone cuts the surface and displaces Holocene (recent) age strata. The nearby Yager fault is interpreted to root in the same zone of thrusting as the Little Salmon Creek fault (McLaughlin et al. 2000). Data on slip rate and estimates on earthquake recurrence intervals indicate that the Little Salmon fault is active and capable of generating very large earthquakes.
- Russ and False Cape Fault Zones. The Russ fault zone juxtaposes Miocene and younger strata (<24 million years) of the Eel River forearc basin (i.e., overlap assemblage) with coeval and older strata of the underlying accretionary complex. The distribution of surface and subsurface earthquakes strongly suggest that the Russ Fault is active at shallow depths (McLaughlin et al. 2000).

The following faults show no evidence of movement during the Quaternary period:

- South Fork Fault. The South Fork Fault (Irwin 1974) a major east dipping fault, separates and thrusts the rocks of the Klamath Mountains over the rocks of the Eastern Franciscan belt of the Coast Range Province. Serpentine and a zone of tectonically mixed rocks have been mapped in areas (e.g., in the Redwood Creek basin) immediately above the South Fork Fault (Young 1978).
- Indian Field Ridge Fault. The surface trace of the Indian Field Ridge fault is found to the west of the South Fork fault and is marked in places by narrow zone of unmetamorphosed pervasively sheared rocks (Cashman et al. 1995).
- Grogan Mountain Fault Zone. The steep northeast dipping Grogan Mountain Fault Zone delineates the channel of Redwood Creek. The zone is defined by an area of metamorphosed and pervasively sheared rocks and separates units of sandstone that mark distinct contrasts in surface topography (e.g., incoherent unit of Coyote Creek and coherent unit of Lacks Creek).
- Bald Mountain Fault. The Bald Mountain fault lies to the west of the Grogan fault and separates unmetamorphosed sandstone and melange units to the west from the metamorphosed units (schists) of the Grogan Fault zone to the east (Strand 1963).
- Snow Camp Creek Fault. The Snow Camp Creek fault is the only major east-west trending fault in the HPAs. The fault is located just south of Pardee Creek in the Redwood basin and it separates (Redwood Creek) schist units on the south from Franciscan sandstone and melange units to the north (Harden et al. 1982).

#### 4.2.1.5 ***Geologic Profile of the HPA Groups***

As noted in Section 1, the 11 HPAs are divided into four HPA Groups for purposes of the applying the initial default slope stability conservation measures (see Section 6). Table 4-1 lists the groups, the HPAs in each group and the dominant bedrock types in each HPA Group. A brief description of each HPA Group follows the table. The geologic features and conditions of the individual HPAs are described in Section 4.4.

**Table 4-1. Bedrock types within HPA Groups.**

<b>HPA Group</b>	<b>HPAs Included in Group</b>	<b>Bedrock Types in HPA Group</b>
Smith River	Smith River	Central Belt Franciscan and minor amounts of Western Jurassic Belt of the Klamath Mountains Province.
Coastal Klamath	Coastal Klamath Blue Creek	Central Belt Franciscan, Western Jurassic Belt (Klamath Mountains province), and minor amounts of Eastern Belt Franciscan Complex and Western Paleozoic and Triassic Belt of the Klamath Mountains Province.
Korbel	Redwood Creek Coastal Lagoons Little River North Fork Mad River Mad River  Interior Klamath	Central Belt Franciscan Complex and limited amounts of Eastern Belt Franciscan, Wildcat Group (equivalent), and Western Jurassic Belt of the Klamath Mountains Province
Humboldt Bay	Humboldt Bay Eel River	Wildcat Group, Yager Terrane, and minor amounts of Central Belt Franciscan Complex.

##### 4.2.1.5.1 *Smith River HPA Group*

The Smith River HPA Group is bisected by the South Fork Mountain Thrust (The Coast Ranges Thrust), which separates Franciscan Central Belt from the Klamath Mountains and Eastern Franciscan Belt bedrock. Both of these geologic terranes underlie Green Diamond's ownership in the Smith River HPA. The Franciscan Bedrock is composed of a mixture of sandstone and mudstone and the Klamath Mountains Bedrock is composed of volcanics and ultramafic intrusive rocks.

##### 4.2.1.5.2 *Coastal Klamath HPA Group*

The Coastal Klamath HPA Group is bisected by the South Fork Mountain Thrust (The Coast Ranges Thrust), which separates Franciscan Central Belt from the Klamath Mountains and Eastern Franciscan Belt bedrock. Most of the Original Assessed Ownership within the Coastal Klamath HPA Group is underlain by undifferentiated Central Belt Franciscan Complex sandstone and mudstone. The South Fork Mountain Schist of the Eastern Belt Franciscan Complex and volcanic and ultramafic rocks of the Western Jurassic Belt of the Klamath Mountains province underlie smaller portions of the Original Assessed Ownership. The steep topography of the two HPAs is a distinguishing landscape characteristic and a primary reason for their grouping.

#### **4.2.1.5.3 Korbelt HPA Group**

The Korbelt HPA Group is located entirely within the Coast Ranges province and is transected by numerous faults, including the Mad River Fault Zone (MRFZ), the Bald Mountain Fault, the Grogan Fault, and the South Fork Fault, which separates the Coast Range province from the Klamath Mountains province. Franciscan Central Belt and Eastern Belt Bedrock comprised of sandstone, mudstone, mélangé, and schist underlies most of the Korbelt HPA Group. Limited occurrences of Wildcat Group equivalent and younger bedrock is found within the MRFZ and along the coast of the Korbelt HPA Group. Limited occurrences of volcanic and ultramafic rocks of the Western Jurassic Belt of the Klamath Mountains province are found at the eastern margin of the Interior Klamath HPA.

#### **4.2.1.5.4 Humboldt Bay HPA Group**

The Humboldt Bay HPA Group is located entirely within the Coast Ranges province and is transected by numerous fault zones, including the Freshwater Fault, Little Salmon Fault, and Russ/False Cape faults. The eastern portion of the region is underlain by sandstone and melange associated with the Central belt of the Franciscan Complex. The Freshwater fault delineates the western boundary of the Central belt and separates it from the rocks of the Wildcat formation (Overlap Assemblage), and the Yager Terrane (argillite, shale, sandstone and conglomerate associated with the Coastal belt of the Franciscan Complex). The Russ/False Cape fault zone roughly delineates the southern boundary of the region, and also separates the Pliocene/Pleistocene materials from a strip of Coastal belt (Yager terrane) rock located just within the southern margin of the region. Most of Original Assessed Ownership in this HPA Group is underlain by the Wildcat Group geologic units.

### **4.2.2 Landform Development**

The topography of the HPAs is highly variable and consists of landforms ranging from steep terrain with deeply incised narrow drainages to rolling landscape with less deeply incised drainage networks. As noted, the region has experienced high rates of Neogene uplift, deformation, and accompanying channel down cutting. Parallel to these processes, the area has experienced relatively high denudation rates, and the upper reaches of many drainages have been sculpted over geologic time by repeated shallow landslides. At present, landslides are common throughout the area and continue to be a major force shaping the modern landscape.

In addition to mass wasting and erosional processes, a dominant factor controlling the variation in topography is the underlying rock mass and associated geologic structure. According to McLaughlin et al. 2000, rock masses larger than a few hundred meters in diameter tend to develop topographic forms related to the erosional and slope-stability properties of the constituent materials. These properties may be controlled by many factors, such as the structural state of the rock mass and orientation of layering. Rates of tectonic uplift may also play a role in the development of topographic form. However, geodetic work indicates that these rates tend to vary gradually and impact broad regional areas rather than more localized areas (e.g., subunits of specific rock terranes located within individual hydrographic planning areas) (McLaughlin et al. 2000).

The spatial variation in dominant rock units or geologic groups in the HPAs is evident in the expression of the local topography. In addition, the contact between the rock units and overlying soil is gradational and varies according to rock unit and topography. The major rock types and associated soils and landforms are as follows:

- Well indurated sandstone rock masses weather to granular (sandy and silty) soil that is stable enough to form steep slopes. The stability and homogeneity of such soils and rock masses tend to result in steep, sharp-crested topography dissected by a regularly spaced array of straight, well-incised sidehill drainages (McLaughlin et al. 2000).
- Units containing unconsolidated and poorly indurated sandstone rock masses rapidly weather when disturbed and are highly unstable. These units tend to form a thick cover of sandy and silty soils, support only gentle hillslopes and poorly incised sidehill drainages, and crests tend to be rounded (Bond, pers. comm.).
- Highly folded broken formations that also include zones of clayey sheared argillitic rock generally correspond to steep topography with generally sharp crests and well-incised but irregular sidehill drainages (McLaughlin et al. 2000).
- Units containing melange with subequal amounts of sandstone and argillite or units that are predominantly made up of argillitic sequences that are highly folded and variably sheared generally have irregular, gently to moderately sloping topography that lacks a well-incised system of sidehill drainages (McLaughlin et al. 2000). Melange areas typically support grassland prairie zones, which are susceptible to gully erosion, especially where overgrazing has increased runoff and road construction has disturbed the natural drainage channels. Although commercial timber grows on land underlain by melange, many such areas were converted to grassland, after harvest and have not produced new timber growth (CA DWR 1982).
- Clayey rock masses, especially where sheared, weather to clayey soil materials. These clayey soils and bedrock are so weak that they can support only gentle hillslopes and poorly incised sidehill drainages, and crests tend to be rounded (Kelsey et al. 1995; McLaughlin et al. 2000).
- Well-indurated rock masses associated with the terranes of the Klamath Mountains province result in very steep, sharp-crested topography. These units typically are overlain by thin soils and are dissected by straight, well-incised sidehill drainages.

#### **4.2.3 Landslide Classifications**

Many types of mass movement occur within the Coast Range and Klamath Mountain provinces. As noted, landslides are common throughout the area. Intense and prolonged rainfall events, combined with area geology, geomorphology, and timber harvesting activities often result in conditions that are highly susceptible to excessive erosion and landslides, especially when high antecedent groundwater conditions exist. Types of landslides in the Original Assessed Ownership and elsewhere in the HPAs are described below based on the classifications in Crudden and Varnes (1996) and DMG Note 50 (CDMG 1997) with modifications to suit the conditions present.

#### **4.2.3.1 *Shallow-Seated Landslides***

Shallow-seated landslides are generally confined to the overlying mantle of colluvium and weathered bedrock but in some instances also may involve competent bedrock. Most shallow landslides are rapid events and commonly leave a bare unvegetated scar after failure.

##### **4.2.3.1.1 Debris Slides**

Debris slides are characterized by a process whereby unconsolidated rock, colluvium, and soil have failed rapidly along a relatively shallow failure plane. In most instances the depth of failure is less than 10 feet. In some instances, however, a debris slide may extend deeper and incorporate some of the underlying competent bedrock. Debris slides often form steep, unvegetated scars in the head region and irregular, hummocky deposits in the toe region. Slide debris often overrides the ground surface near the toe. Debris slides may exist individually or coalesce to form a larger landslide complex. Slides often continue to move for several years following initial failure. Most natural debris slides are triggered by elevated pore water pressures resulting from high intensity and/or long duration rainfall or from being undercut by stream erosion. The occurrence of high ground accelerations resulting from earthquakes on nearby faults may also result in shallow slope failures either directly or indirectly by reducing soil strength and altering the groundwater regime. In many managed watersheds, a common cause of debris slides is thick, over-steepened road fill associated with old roads, skid trails, and landings that generally predate current FPRs.

##### **4.2.3.1.2 Debris Flows/Torrents**

Debris flows and debris torrents are characterized by long stretches of bare soil and generally unstable channel banks that have been scoured by the rapid movement of debris. Failure typically begins as a debris slide but quickly mobilizes into a flow or torrent as material liquefies, traveling rapidly downslope. These landslides occur most commonly on very steep slopes at or near the axis of small swales or stream channels. As a debris flow/torrent moves through first and second order channels, the volume of material may increase to a much greater size than the initial failure. It is not unheard of for a large debris torrent to deliver over ten thousand cubic yards of sediment to a stream channel.

##### **4.2.3.1.3 Channel Bank Failures**

Channel bank failures are defined as small shallow debris slides that occur along the banks of stream channels. Such failures are a result of undercutting of the stream bank by stream incision or stream widening. Large channel bank failures that extend far up an adjacent hillslope may become difficult to distinguish from debris slides. Because such failures are relatively common along streams they have been classified separately from the other failures.

##### **4.2.3.1.4**

### Rock Falls

Rock falls are characterized by catastrophic failure of relatively steep rock slopes or cliff along a surface where little or no shear displacement takes place. Generally rock debris accumulates at the toe of the slope. Rock falls are relatively uncommon in the planning area.

#### **4.2.3.2 Deep-Seated Landslides**

Deep-seated landslides typically have a basal slip plane that extends into bedrock. Most deep-seated failures move incrementally; catastrophic failure is relatively rare. Active slides are typically vegetated with trees and/or grass.

##### **4.2.3.2.1 Translational/Rotational Rockslides**

Translational/rotational rockslides are characterized by movement of a relatively intact slide mass with a failure plane that is relatively deep when compared to that of a debris slide. The slide plane typically extends below the colluvial layer into the underlying and more competent bedrock. The slides often have a distinct toe at the base of the hillside and undercutting of the toe of the slope by streams plays a key role in their long term stability. Translational/rotational rock slides are identified by a broad arcuate headscarp and a series of mid-slope benches on what is otherwise moderately to steeply sloping terrain. Sag ponds, hummocky topography and springs and patches of wet ground may be present. Commonly the landslide consists of several smaller slide blocks that coalesced together to form the larger landslide complex. Lateral scarps between the individual landslide blocks are often poorly defined, in part due to the low rate and/or infrequent movement of the slide mass. Differential movement between individual slide blocks is common. Where slide movement is most active, drainage networks and stream channels are shallow and generally poorly to moderately defined. Movement is most apparent in the upper portion of the hillside and less apparent near the toe. Steep main scarps, secondary internal slide scarps, and toe slopes may be subject to debris sliding.

##### **4.2.3.2.2 Earthflows**

Earthflows are characterized by a relatively large semi-viscous and highly plastic mass resulting in a slow flowage of saturated earth. Most earthflows are comprised of a heterogeneous mixture of fine-grained soils and rock. Earthflows may range from less than one acre to hundreds of acres. The depth of failure is varied but typically greater than 15 feet and the degree of activity is varied: many earthflows are dormant while others exhibit seasonal creep in response to high rainfall. Rapid movement of such failures is rare. Ground displacement is generally slight, and catastrophic failure of the slope is unlikely. Slide materials erode relatively easily, result in gullying and irregular drainage patterns, and may be reactivated in response to removal of toe support, high rainfall events, and possibly by large seismic events. Because of the seasonal movement associated with some of these slides, earthflow areas often are unable to support forest stands. Small earthflows may be influenced by poor road drainage across the toe of the slide.

#### **4.2.4 Landslide-Prone Terrains**

Both deep and shallow landslides occur within the Original Assessed Ownership and elsewhere in the HPAs, with shallow landslides most common on slopes steeper than 60% to 70%. In general, steep streamside slopes, inner gorge slopes, steep headwall swales, and breaks-in-slopes have been identified as being potentially higher risk areas for producing shallow landslides compared to adjacent slopes. Landslides are also more frequent in areas of convergent slope form where surface and ground waters tend to concentrate and where colluvial soils tend to be thickest. The most prevalent landslide-prone terrains are described below.

##### **4.2.4.1 Steep Streamside Slopes**

Steep streamside slopes are defined as steep slopes located immediately adjacent to a stream channel, and generally formed, over time, by coalescing scars from shallow landsliding and stream erosion. These slopes typically exceed 65% gradient where stream incision has undercut the toe of the slope, and descend directly to streams without intervening topographic benches. Preliminary landslide inventories in the planning area indicate that roughly 60% to 90% of all shallow landslides initiate on steep streamside slopes. All steep streamside slopes show evidence of modern landslide processes (less than 50 years old) when slopes are examined on a sub-basin level.

##### **4.2.4.2 Inner Gorge**

An Inner Gorge is a subset of steep streamside slopes where a more-or-less distinct break-in-slope separates steeper "Inner Gorge" slopes below the break-in-slope from lower gradient slopes above the break. The steep streamside slopes classification includes Inner Gorge slopes as well as those steep slopes where a distinct break-in-slope is absent.

##### **4.2.4.3 Headwall Swales**

Many shallow landslides occur within headwall swales upstream of Class III watercourses, where convergent topography forces both the accumulation of thick soils and the concentration of shallow subsurface runoff along the axis of the valleys. Headwall swales are characterized by areas of narrow, steep, convergent topography (swales or hollows) located at the heads of Class III watercourses (i.e. an unchanneled swale extending upstream of a watercourse) that have been sculpted over geologic time by repeated debris slide and debris flow events. The sideslopes leading into the swale are typically greater than 70%. Slopes are often smooth to slightly irregular, unbroken by benches. Swales often have an inverted teardrop or spoon shaped appearance. Seasonal seeps, springs and wet areas may exist within the axis of the swale toward the base. The soil and colluvium depth is often much deeper within the axis of the swale than on the adjoining side slopes. The surface expression of the swale may be distinct to subdued. The width of headwall swales is highly variable ranging between 30 and 100 feet.

## **4.3 METHODS AND RESULTS OF STUDIES IN THE ORIGINAL ASSESSED OWNERSHIP**

This Section summarizes the methods and results of various studies conducted by Green Diamond and others to collect and analyze information about the condition of aquatic habitats and the occurrence of Covered Species in the Original Assessed Ownership and provide a basis for analyzing other commercial timberlands in the Eligible Plan Area. The Original Assessed Ownership in the 11 HPAs is depicted in **Figure 1-1** and constitutes approximately 99% of the Initial Plan Area as estimated in Section 1 (see Table 1-1). Additional details regarding the objectives, methods, results, discussions, and conclusions of the studies are presented in Appendix C.

Except as noted, all studies summarized in this subsection were conducted on the Original Assessed Ownership in the 11 HPAs. Some of these studies also extended into areas outside the 11 HPAs, but only data and analysis for lands in the HPAs are presented here.

### **4.3.1 Water Temperature Monitoring**

Stream water temperature monitoring has been conducted in the Original Assessed Ownership since 1994. Presently there are two water temperature-monitoring programs: general water temperature monitoring in Class I and II watercourses, and a modified before-after-control-impact (BACI) study of water temperatures Class II watercourses (see Appendix C5.1 and C5.2 for details).

#### **4.3.1.1 General Water Temperature Monitoring**

The general water temperature monitoring program is designed to:

- Determine the seasonal temperature fluctuations for each monitored site; :
- Document the highest 7-day moving average (7DMAVG) of all recorded water temperatures;
- Document the highest 7-day moving average of the maximum daily (7DMMX) water temperatures; and
- Identify watercourse reaches with temperatures that have the potential to exceed the MWAT temperature monitoring thresholds relative to the drainage area above the monitoring site.

By the end of 2000, Green Diamond had recorded and/or collected 400 temperature profiles in approximately 108 Class I watercourses and 210 temperature profiles in approximately 70 Class II watercourses. The data from these profiles were used to calculate the 7DMAVG, 7DMMX, absolute maximum, the minimum temperature following the maximum temperatures, as well as the associated dates of occurrence. Various attributes have been collected for many of these monitoring stations, specifically watershed area. The summary of the 7DMAVG water temperature for each stream monitoring site in relation to the square root of its watershed area above the monitoring site is shown in Figure 4-2.

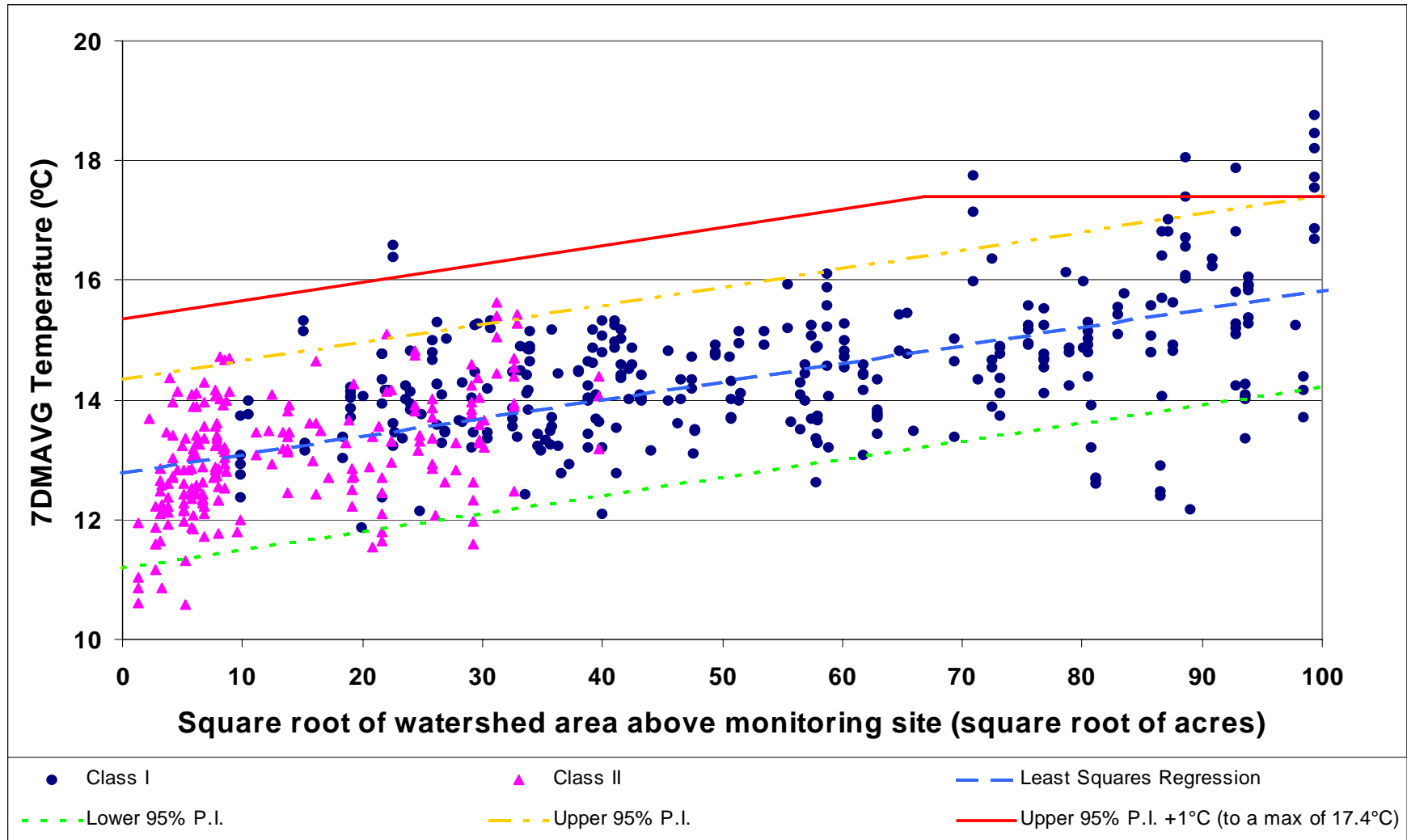


Figure 4-2. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the 11 HPAs monitored between 1994 and 2000.

Of the 400 Class I temperature profiles, 375 (93.8%) were at or below the suggested MWAT threshold of 17.4 °C in the Aquatic Properly Functioning Condition Matrix (NMFS 1997). Green Diamond believes that the single MWAT threshold value of 17.4 °C fails to account for natural variations in water temperature due to geographic location, climatic factors and drainage area of the monitored sub-basin. For this reason, future water temperatures will be evaluated based on the yellow and red light thresholds that were developed for this Plan (see below for brief description of the thresholds; see Section 6 for detailed description and discussion). Exceeding a yellow light temperature threshold would result in an internal review by Green Diamond to determine causes and management actions that may be necessary to rectify elevated water temperatures if practicable. Similarly, exceeding a red light threshold would result in a review by NMFS, USFWS, and Green Diamond to determine causes and management actions that may be implemented to rectify excessive water temperatures. As discussed below, the expected temperature threshold for a monitoring site will be based on its watershed size rather than a generic threshold value applied equally to all streams.

To develop a relationship between water temperature and watershed drainage area, Green Diamond regressed water temperature on the square root of drainage area at locations known to support populations of southern torrent salamanders, tailed frogs, or coho salmon. The relationship of water temperature and watershed area was examined to help account for the observed natural variation in water temperature. Furthermore, and to establish biological objectives and threshold values, Green Diamond used the upper 95% prediction interval (PI) of individual sample sites as the yellow light threshold for drainages up to approximately 10,000 acres (=100 acres squared). (A prediction interval is based on the probability that a sample point will occur within a specified interval.) One degree above the upper 95% PI was set as the red light threshold until a maximum of 17.4 °C was reached. These monitoring thresholds are shown on Figure 4-2. It should be noted that using the regression of water temperature versus drainage area to establish biological objectives and threshold values was only intended to apply to 4<sup>th</sup> order or smaller streams that generally occur in drainages less than 10,000 acres. As indicated in Figure 4-2, the red light threshold was exceeded 11 times in 5 different locations over the monitoring period (1994-2000). The streams, years, and size of watershed where the red light threshold was exceeded are as follows:

- Coyote Creek (Redwood Creek HPA); Year: 2000; Watershed area: 5,025 acres.
- Lower Cañon Creek (Mad River HPA); 1996 through 2000; 9,869 acres.
- Middle Cañon Creek (Mad River HPA); 2000; 8,620 acres.
- Salmon Creek (Humboldt Bay HPA); 1997 and 1998; 7,858 acres.
- Stevens Creek (Eel River HPA); 1999 and 2000; 506 acres.

As part of the implementation of this Plan, Green Diamond will continue to evaluate these monitoring sites as outlined in Section 6.2.5.

#### **4.3.1.2 Class II BACI Study**

The Class II BACI study was initiated in the summer of 1996 to examine the adequacy of riparian buffers in maintaining water temperatures following timber harvest. Streams in five areas where timber harvest was planned were identified and paired with separate streams in close proximity that have similar size, streamflow, aspect, elevation, stand

type, stand age, and streambed geology. The stream running through a harvested area was designated as the “treatment” site. The other stream of each pair was designated as the “control” site. The five pairs selected in 1996 include:

- One pair in the headwaters of Dominie Creek (D1120) in the Smith River HPA ;
- One pair of tributaries to the South Fork Winchuck River (D1120 in the Smith River HPA ;
- One pair in the headwater tributaries of the Little River (Mitsui) in the Little River HPA;
- One pair off the mainstem Mad River in the Mad River HPA; and
- One pair in the headwater tributaries of Dominie Creek in the Mad River HPA.

In 1999, three pairs were added to the study:

- Two pairs of tributaries to Maple Creek (Windy Point and M1) in the Mad River HPA; and
- One pair of tributaries to the Lower South Fork Little River (M155) in the Little River HPA.

At least one year prior to timber harvest, paired temperature-recording devices (HOBO's® or TitBiTs®) were placed in the treatment stream at the upstream and downstream edges of the harvest unit. At the same time, another pair of temperature recording devices were placed in the control stream at locations which are the same (stream) distance apart as the recording locations in the treatment stream. The paired thermographs were deployed to all streams in middle and late spring each year and collected after 15 September each year. The upstream and downstream placement of temperature recording devices allowed measurement of temperature differential across the treatment area and an assessment of the extent to which water temperature changed as it flowed through the treatment area. Interest is primarily in the amount of warming water experiences as it flows through the treatment area. Ground water inputs, climate, and microclimatic factors can all affect water temperature and consequently the paired stream design was adopted. Data collection from each pair began when the thermographs were placed (at least one year prior to timber harvest) and will continue for at least three years after harvest or until the temperature profile of each pair returns to the pre-treatment pattern.

Following data collection, a modified BACI analysis will be used to assess harvest impacts. BACI analyses assess the lack of parallelness in response profiles through time. This lack of parallelness is measured by the treatment by time (year) interaction from an ANOVA with time as one factor and treatment as the other. The BACI analysis allows the level of responses to be different between control and treated sites both before and after treatment, but requires the after treatment difference in control and treated responses to be the same as the before treatment difference in control and treated responses. If the after treatment difference in responses is different from the before treatment difference in responses, the BACI analysis will conclude that there was significant change in treatment areas after application. Inference as to the cause of

treatment differences will be a professional judgment based on a preponderance of evidence. Each site also will be analyzed separately so no statistical inference to other sites is possible.

The study is still in its data collection phase on pairs where the treatment site was harvested after 1999 or have yet to be harvested. However, as described in more detail in Appendix C5.2, a preliminary analysis has been conducted of data from four pairs harvested before 1999 (Mitsui, D2010, 6001, and 5410). In general, the analysis indicates that all of the treatment streams showed a significant change in water temperature relative to the controls streams following timber harvest. However, the treatment streams were warmer in two pairs and colder in the other two. There are no other data to help provide clues as to why these sites responded in opposite directions to timber harvest, but Green Diamond speculates that it may be due to altered hydrology. Clearcutting adjacent to a stream should increase the amount of water that is retained in the soil for a few years following harvest primarily due to a reduction of evapotranspiration water losses. If some treatment streams had groundwater inputs while others did not, it would be possible that the increased groundwater could result in relatively cooler water temperatures following harvest in those treatment streams with groundwater inputs. Those treatment streams without significant groundwater inputs would have the greater potential to experience increases in water temperature following harvest. If this pattern persists in additional monitored sites, one would conclude that the cumulative effect of timber harvest on water temperature in small Class II watercourses within a watershed should net to zero.

The Class II BACI study will continue under the Plan, as described in Section 6.2.5.

#### **4.3.2 Channel and Habitat Typing Assessments**

A total of 58 streams were assessed between 1994 and 1998. Channel and habitat typing assessments were conducted using the CDFG methods described by Flosi and Reynolds (1994). Green Diamond assessed sixteen streams for a total of over 94 miles of stream channel (see Appendix C1). An additional 42 streams (135 miles of channel) were assessed by the following organizations:

- Yurok Tribal Fisheries Program (1996-1998) - 31 streams
- California Conservation Corp (1995) - 3 streams
- Louisiana Pacific Corporation (1994) - 4 streams
- California Department of Fish and Game (1991 and 1998) - 4 streams

Tables C1-1 through C1-8 in Appendix C1 identify the assessed streams; also see the HPA assessments in Section 4.4.

To summarize, compare, and assess stream channel and habitat parameters, channel and habitat typing variables were plotted against stream watershed area. The watershed area was determined at the midpoint of the surveyed reach of each stream. The dry sections of channel in the lower portion of the watershed were not included in the overall stream length. The midpoint of the wetted channel length normalizes the stream size based on the relative position in the watershed where the survey occurred and the mean values of interest.

To allow for a comparison of pool tail-out embeddedness between streams, a stream gradient was determined from the channel types. Each channel type has a delineation criteria based on a range of channel gradients (see Appendix C1). To derive an average stream gradient, the mean gradient of each channel type criteria was weighted according to the length of each channel type. The least squares regression for variables also was calculated (for comparison purposes only, not for statistical analysis). The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs. The  $R^2$  and p values are also shown on the figures in Appendix C1.

The results of these assessments are summarized below and depicted in Figure 4-3 (A-F).

- Mean canopy closure for the assessed streams ranged from 36-99% with an inverse relationship between water temperature and watershed area. Of the assessed streams, 69% had a mean canopy closure greater than or equal to 80% (Figure 4-3 [A]).
- Percentage of conifer canopy cover for the assessed streams ranges from 2% to 77% (Figure 4-3 [B]). Deciduous trees dominate the riparian canopy along the assessed streams, with 67% containing less than 20% conifers along the riparian margin. The percentage of conifer canopy increases slightly with increased stream watershed area.
- Percentage of total stream length in pools varies from 4% to 81% in the assessed pools and is particularly variable in streams with watershed areas less than 5,000 acres (Figure 4-3[C]).
- Percentage of LWD as structural shelter in pools ranges from 0% to 55% in the assessed streams (Figure 4-3 [D]). In streams with watershed areas less than 5,000 acres, the percentage varies greatly (0% to over 50%). In streams with watershed areas greater than 5,000 acres, the percentage is much lower on average than in streams with smaller watershed areas.
- Maximum residual pool depth, which is used to classify primary pools, is shown for the assessed streams in Figure 4-3[E]. The average for all 58 streams is approximately 2 feet. The streams with larger watershed areas have deeper pools than those with smaller watershed areas.
- Most of the assessed streams are 3<sup>rd</sup> order or less and in small drainages. A primary pool in a 3<sup>rd</sup> order or larger stream would be expected to have a depth of 3 feet or greater. However, pools with residual depths greater than 2 feet also may act as primary pools (i.e., provide temperature refugia and function as summer habitat for juvenile salmonids during low flow conditions).

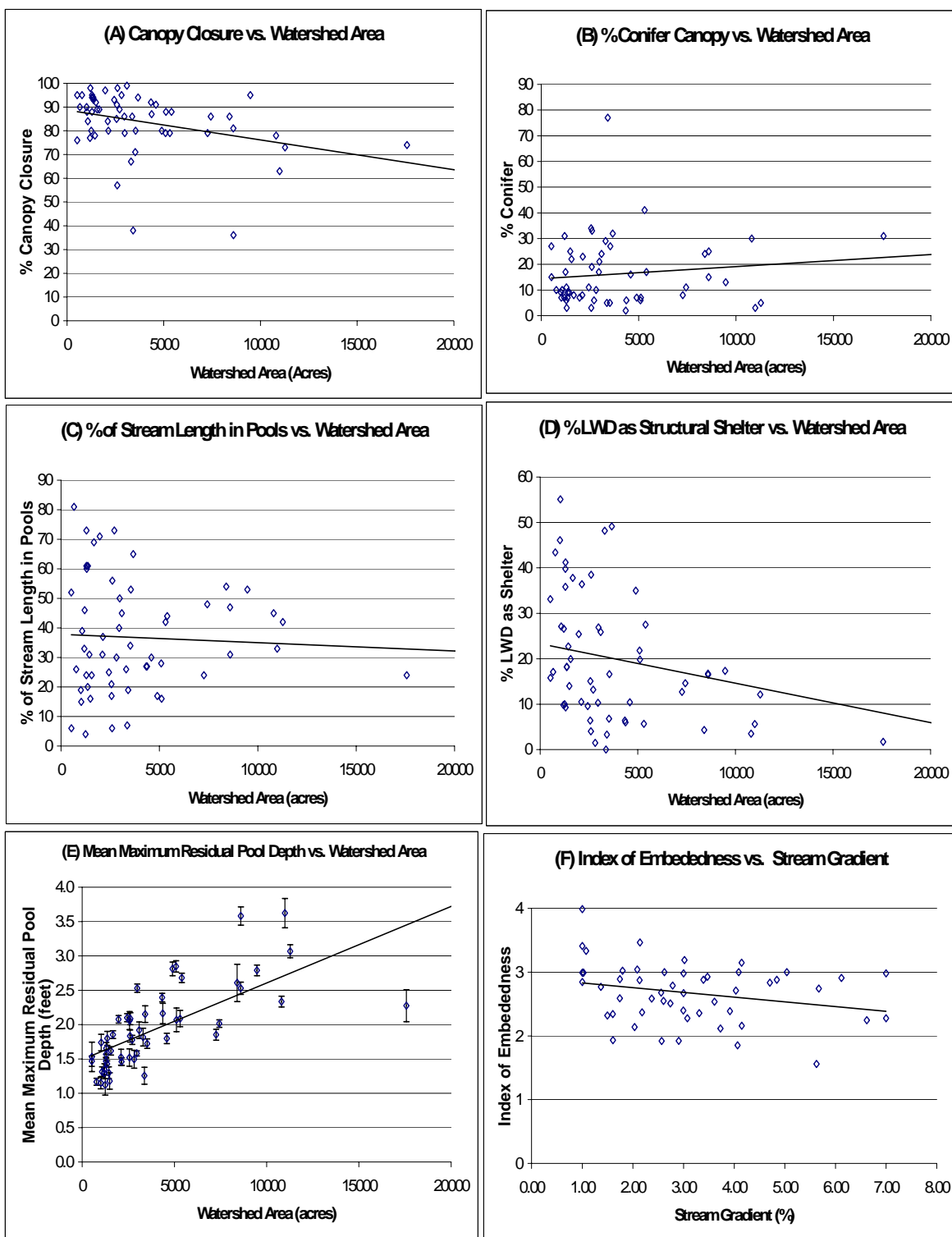
- In 41 (71%) of the assessed streams, more than 40% of the pools have residual depths greater than 2 feet. In 14 (24%) of the assessed streams, more than 40% of the pools have residual depths greater than 3 feet. The estimated embeddedness index values for the assessed streams generally is within a range of 2 to 3 (>26% < 75% embedded), regardless of stream gradient (Figure 4-3 [F]). On the average, the embeddedness index rating diminishes slightly for streams with larger watersheds.

In summary, the assessed streams with greater watershed areas tend to have less canopy closure but a greater percentage of conifer canopy than those with smaller watershed areas. Pools within streams with smaller watersheds have a greater percentage of LWD as structural shelter than streams with larger watershed areas. The average maximum pool depth increases and pool tail-out embeddedness decreases as the watershed area increases.

#### **4.3.3 LWD Assessments**

LWD assessments were conducted on 20 streams: 16 streams were assessed by Green Diamond, and 4 were assessed by Louisiana Pacific (LP). In addition, a cooperative effort by Redwood National Park and NMFS inventoried in-channel LWD in 4.3 miles of Prairie Creek in Prairie Creek State Park (Redwood Creek HPA). Prairie Creek is considered to be the best remaining example of a relatively undisturbed watershed dominated by old growth redwood forest.

Green Diamond's LWD surveys were conducted in 1994 and 1995 using CDFG methods (Flosi and Reynolds 1994). The surveys applied a 20% sampling approach and covered two zones: the bank-full discharge area of the stream channel and the "recruitment" zone. LP's LWD inventory for Little River and three of its tributaries was conducted in 1994 and used a 100% approach. This inventory tallied all in-channel pieces of LWD within the bank-full margins; no riparian or recruitment zone inventories were conducted. To address potential differences in methodologies used for the assessed streams, Green Diamond conducted a 100% inventory on all of the streams surveyed in 1995 while simultaneously using CDFG 20% sampling approach. This allowed for a direct comparison of the CDFG methodology to a known inventory and allowed for a determination of the accuracy of a 20% sample. The Prairie Creek inventory was conducted in 1999 using a 100% approach. It is considered a true piece count and can be directly compared to both the CDFG 20% samples and the 100% inventories. The details of the investigations are presented in Appendix C2, with the names of the assessed streams identified in Tables C2-1 through C2-14. The results of are summarized below and shown in Figure 4-4 (A-C) in terms of mean values for the length of stream surveyed.



**Figure 4-3.** Channel and habitat types in 58 streams in the 11 HPAs assessed between 1994 and 1998. (Watershed area measured at the midpoint of the surveyed reach. Bars represent plus or minus one standard error. Stream gradient determined based on channel type and length.)

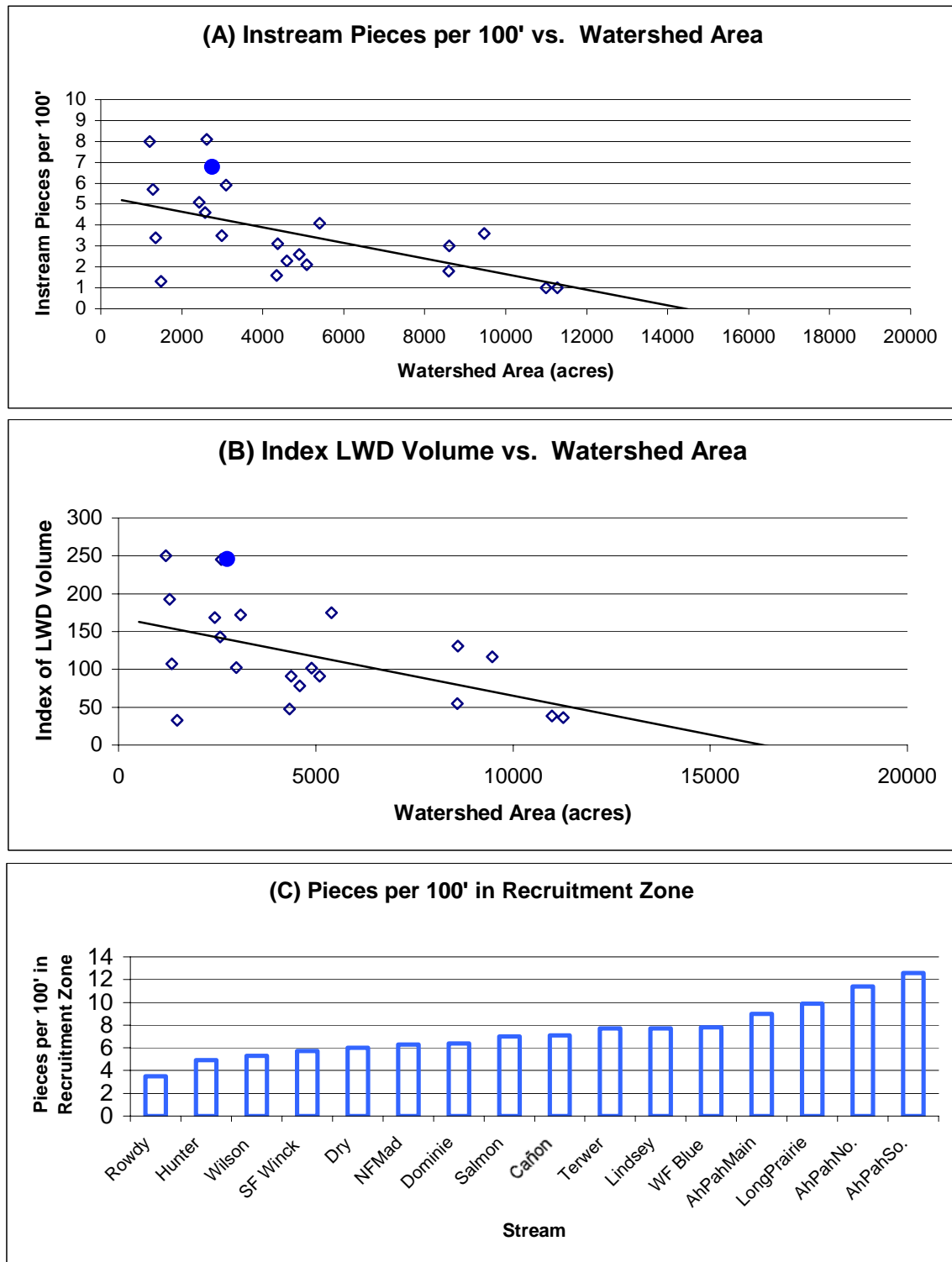
Figure 4-4 (A) and (B) show in-stream LWD pieces per 100 feet of channel and LWD volume index versus watershed area of the surveyed streams. The watershed area was determined at the midpoint of the surveyed reach of each stream. The dry sections of channel in the lower portion of the watershed were not included in the overall stream length. The midpoint of the wetted channel length normalizes the stream size based on the relative position in the watershed where the survey occurred and the mean values of interest.

- As seen in Figure 4-4(A), the number of in-stream pieces of LWD per 100 feet of channel in the assessed streams diminishes as watershed area increases. The streams with watershed areas similar to Prairie Creek have on average 4-5 pieces of LWD per 100 feet of channel (approximately 30% less than the nearly 7 pieces per 100 feet for Prairie Creek).
- As seen in Figure 4-4 (B), the LWD volume index for the assessed streams diminishes as watershed area increases and, for streams with comparable watershed areas, is approximately two-thirds of that for Prairie Creek.
- For the 16 streams where recruitment zone surveys were conducted, the number of LWD pieces in the riparian zone ranged from less than 4 to greater than 12 pieces per 100 feet of channel (Figure 4-4(C)).

In summary, the occurrence of larger in-channel pieces of LWD is lower in the 20 assessed streams than in Prairie Creek. Several of the assessed streams had average overall piece counts per 100 feet within specific size categories that approached or exceeded the values seen in Prairie Creek. However, the piece lengths in the 20 streams were shorter than the piece lengths in Prairie Creek, especially in similar channel types.

In the 20 assessed streams, most of the larger diameter LWD was either: 1) old-growth root wads with little or no bole attached to them, or 2) in-stream restoration projects consisting of short, stubby pieces of cull logs anchored to bedrock, boulders, or riparian trees. Both of these types of LWD often provide marginal habitat compared to intact trees recruited from the riparian zone. Old-growth redwood rootwads contain fairly large volumes of wood, yet their short length provides minimal surface area for capturing and retaining additional LWD to form complex salmonid habitat. The short length of these rootwads also increases their likelihood of mobilizing during moderate storm events (as occurred during the winters of 1995-96 and 1996-97).

LWD within Plan Area streams will be reassessed periodically during the 50-year life of the Plan with the objective of documenting changes in conifer piece frequency, size, and functionality. Conditions can be expected to gradually improve as a result of current FPRs and the increased riparian standards implemented under the Plan. The hardwood dominated riparian zones now prevalent in the Original Assessed Ownership in the 11 HPAs will eventually be succeeded by redwoods and other conifers, resulting in increasing recruitment of large diameter LWD for Plan Area streams.



**Figure 4-4.** LWD survey results for 20 streams in the 11 HPAs assessed between 1994 and 1999. (Watershed area measured at mid-point of surveyed reach. Open diamonds are the assessed streams. Large circle indicates comparable data for Prairie Creek.)

#### **4.3.4 Class I Channel Monitoring**

Green Diamond is monitoring representative stream reaches on its ownership in the HPAs to capture specific channel responses to significant hydrologic events (and possibly management activities). Only variables that are independent of flow are measured. The protocol was implemented first on Cañon Creek (a tributary in the Mad River HPA) in 1995. During 1996, the Cañon Creek site was monitored again, and additional channel monitoring reaches were established on Canyon Creek (a tributary in the North Fork Mad River HPA), South Fork Winchuck River (a tributary in the Smith River HPA), Hunter Creek (Coastal Klamath HPA), and Salmon Creek (Humboldt Bay HPA). The surveys have continued since 1996, with scheduled re-surveys every two years or after a five year flood event. Details of the channel monitoring projects analyzed to date are presented in Appendix C3.

The purpose of the monitoring protocol is to document the recovery of Plan Area watersheds from past timber harvesting practices and to evaluate the effects of current and future harvesting practices on watershed condition and recovery. The long-term channel monitoring protocol also has potential to evaluate the effectiveness of “storm-proofing” techniques, currently in vogue, in reducing road-related erosion sources. The monitoring objective of the Class I channel monitoring project is to track long term trends in the sediment budget of Class I watercourses as evidenced by changes in channel dimensions. These dimensions include thalweg profile, thalweg elevation (defined as the height of the deepest part of the channel), bankfull width, active channel width, and substrate (pebble) size.

Data collected on all of the monitoring sites since 1998 are scheduled for analysis in 2003. Each monitoring reach should have at least 3 years of data prior to the first analysis and updated biennially to coincide with the biennial report to the Services (see Section 6 regarding report). This is a long term monitoring study, and therefore Green Diamond does not expect to be able to determine trends in the sediment budget of Class I watercourses for possibly 10-15 years. Threshold values for monitoring can not be established until lag times and the ranges of natural variability for individual watersheds or sub-basins are understood. In the interim period, Green Diamond expects to gain useful insights concerning the relationship between channel dynamics and hillslope processes within the Plan Area. By integrating data from different monitoring approaches, Green Diamond believes that channel monitoring will ultimately be a powerful tool for better understanding of the relationship between management activities and stream habitat conditions for the Covered Species in the Plan Area.

#### **4.3.5 Assessment of Sediment Delivery from Class III Watercourses: A Retrospective Study**

Concerns have been raised that complete removal of trees from Class III watercourses will result in destabilizing these headwater areas resulting in an upslope extension of the channel and increased risk of shallow rapid landslides. The net effect is that there could be significant increases in sediment production from watercourses even though Class I and II watercourses may have ample buffer retention. A retrospective study was used to provide a description of key variables of Class III watercourses sampled and quantify gross changes that might have occurred following clearcut timber harvesting (see Appendix C4 for details). Since this was a retrospective study and it was not possible to

utilize controls, it was expected that subtle changes in Class III watercourses following timber harvest could not be quantified. The objective was to assess the extent to which major changes occurred in Class IIIs that were responsible for substantial increases in management related sediment production.

A stratified random sampling approach was used to select THPs throughout Green Diamond's ownership that had been completed between 1992 and 1998. THPs were not selected before 1992, because of a property-wide shift in the designation of Class II versus III watercourses. Prior to that year, many small intermittent channels were classified as Class IIIs that would have been designated Class IIs after 1992. THPs were not selected after 1998 to insure that Class IIIs had experienced at least one winter of storms. Of all THPs reviewed, 47 "run-through" and 53 "within" channels were selected for the study. A "run-through" is a Class III watercourse where the beginning of the channel is outside the harvest unit. If the channel begins within the boundaries of the harvest unit, it was designated as "within." Table 4-2 summarizes the characteristics of the watercourses of the study (also see Appendix C4).

**Table 4-2. Characteristics of Class III watercourses examined in retrospective study of 100 sites from THPs completed between 1992 and 1998.<sup>1</sup>**

Variables	Run-through		Within		Total	
	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)
Drainage area (acres)	47	10.5 (2.48)	53	5.6 (0.66)	100	7.9 (1.24)
Channel length (ft)	47	451.5 (31.62)	53	346.1 (34.46)	100	395.6 (24.02)
Channel width (ft)	47	2.55 (0.147)	53	2.69 (0.234)	100	2.62 (0.140)
Channel depth (ft)	47	0.33 (0.029)	53	0.25 (0.002)	100	0.29 (0.019)
X-section area (ft <sup>2</sup> )	47	0.96 (0.146)	53	0.67 (0.083)	100	0.81 (0.083)
Channel gradient (%)	47	31.5 (1.79)	53	35.2 (1.81)	100	33.4 (1.28)
Bank slope (%)	47	47.4 (2.481)	53	43.0 (2.61)	100	45.1 (1.81)
Exposed bank (%)	47	0.66 (0.113)	53	1.00 (0.343)	100	0.84 (0.189)
Note						
1 Cross-sectional area of the channel represents the product of the active channel depth and width measurement.						

This study suggested that there were no catastrophic short-term effects (1-7 years) of timber harvest on erosion in and near Class III channels for the period 1992-1998. There were few sites that experienced extensive bank erosion and less than 25% of 10-foot channel segments/intervals contained an exposed active channel. Furthermore, of the 100 sites examined, there were no debris flows. This is significant in that there were several potential triggering storms in this period 1996 and 1998 and there was above average total rainfall in all years except 1992 and 1994. It may therefore be concluded that under the recent regime of harvest practices, Class III channels were not responding to harvest in the short-term by unraveling and causing major increases in sedimentation downstream. However, these results do not rule out the possibility that there were increases in sediment production from more subtle and chronic sources, or that a longer period of study might reveal changes not recognized in this investigation. Most of the sediment production from Class IIIs were limited to a relatively few streams, particularly in regions with unconsolidated geology. This suggests that effective mitigation can be provided by site specific geologic review where conditions warrant.

This retrospective study also showed that there were few landslides associated with Class III watercourses. Those landslides that did occur were associated with steeper stream gradients and steeper bank slopes. These two variables explained over 40% of the variation in landslides among streams and accounted for over two-thirds of the variation explained by the full regression model.

Since there were no controls, this study design was not capable of assessing whether the observed erosion indicators differed significantly from either virgin old growth or advanced second growth forest stand conditions. In particular, it provided no clear evidence regarding whether predicted increases in peak runoff have induced significant increases in rates of fluvial erosion. As a result, a before-after-control-impact (BACI) experiment has recently been initiated for evaluating more subtle changes in sediment production from Class III watercourses. The initial BACI data set collected for the Little River HPA suggests that control-treatment comparisons may not show significant harvesting effects in that region.

#### 4.3.6 Section 303(d) Impaired Watersheds

As part of the examination of habitat conditions, the status of watersheds in the HPAs under the federal Clean Water Act (CWA) was considered. Section 303(d) (33 USC §1313) of the CWA established the Total Maximum Daily Load (TMDL) process which is a three step methodology to assess, prioritize, and develop action plans required to attain water quality standards within watersheds identified as having impaired water quality. These impairments can be as a result of point source, nonpoint source, and naturally occurring sources of pollution. The listed northcoast rivers (Table 4-3) were identified by the State Water Resources Control Board (SWRCB) in 1998 and approved by the United States Environmental Protection Agency (USEPA) on May 12, 1999 as water bodies with impaired or threatened water quality stemming, in part, from silvicultural and rangeland activities.

**Table 4-3. CWA Section 303(d) Impaired Watersheds in the HPAs as determined by the SWRCB and USEPA.**

Watershed	Pollutants	Targeted TMDL Completion Date
Klamath River	Temperature, Nutrients	2004
Redwood Creek	Sediment	1998 <sup>(1)</sup>
Mad River	Sediment, Turbidity	2007
Eel River	Temperature, Sediment	2006
Van Duzen River	Sediment	1999 <sup>(1)</sup>
<b>Notes</b>		
(1) Technical portion of TMDL adopted by EPA.		

#### **4.3.7 Fish Presence/Absence Surveys**

Fish presence/absence surveys are conducted continually on Green Diamond's ownership in the HPAs. The purpose of these surveys is to identify a stream reach of interest as a Class I (fish bearing) or Class II (non-fish bearing) watercourse. A key assumption of these surveys is that only the presence of fish species can be absolutely proven. Absence of fish can only be inferred from a lack of presence. For a further discussion of objectives and methods, see Appendix C6.

All information from the presence/absence surveys is entered into Green Diamond's Forest Resources Information System (FRIS), and the results are incorporated into THPs as they are being prepared. A series of FRIS maps are continuously updated with information obtained from the presence/absence surveys. The maps and database provide current information on the distribution of fish on a property-wide basis.

A presence/absence survey is a valuable technique to establish Class I watercourse determinations and fish species distributions on a site-specific basis. The extent of anadromy for streams on the ownership is generally known, with the exception of the actual extent for each individual species. The presence/absence surveys are primarily used to delineate the extent of resident populations of rainbow and coastal cutthroat trout in low order Class I watercourses.

#### **4.3.8 Summer Juvenile Salmonid Population Estimates**

Surveys to estimate and monitor summer populations of juvenile salmonids have been conducted in eight streams. Data collection on summer populations of juvenile coho salmon and 1+ and older steelhead was initiated in 1995 in three streams: South Fork Winchuck River (Smith River HPA), Wilson Creek (Smith River HPA), and Cañon Creek (Mad River HPA). Since 1995, data collection has occurred annually in these three streams for chinook salmon and coastal cutthroat trout as well as coho salmon and steelhead. Sampling surveys were initiated in 1998 in four additional creeks: Hunter Creek (Coastal Klamath HPA); Lower South Fork Little River, Railroad Creek, and Upper South Fork Little River (all Little River HPA). Sullivan Gulch (North Fork Mad River HPA) was added to the program in 1999.

A modified Hankin and Reeves (1988) juvenile sampling protocol is used to estimate the juvenile populations (Hankin 1999). The estimated population during summer low flow periods (August-September) represents juvenile salmonids that will be shortly out-migrating or over-wintering in streams on the ownership. Details of the population surveys are provided in Appendix C7.

In summary, the summer population estimates for the surveyed streams indicate the following:

- Juvenile coho salmon population estimates vary from stream to stream and year to year. In data sets that span a period of five years, juvenile coho population estimates vary widely, increasing in some streams and decreasing in others. Overall, the surveyed streams north of Redwood Creek show a downward progression in coho populations; the streams south of Redwood Creek show relatively stable or increasing populations (see Appendix C7). Studies within these streams have not occurred long enough to infer trends; however, factors such as low winter flows and poor ocean conditions can contribute to poor adult escapement and thus low juvenile recruitment. Steelhead population estimates indicate stable or increasing populations both north and south of Redwood Creek (see Appendix C7; also see Appendix C10 for Mad River steelhead population estimates). Juvenile populations within streams north of Redwood Creek tend to show the highest population estimates. Within these streams, habitat conditions may be more suited for this species that has behaviors adapted for swift flowing, higher gradient watercourses, with reduced velocity refuge. Distinguishing coastal cutthroat from steelhead while snorkeling is often difficult. Population estimates are calculated for both of these species; however, the estimates may not reflect the actual populations for each species individually. Juvenile coastal cutthroat populations tend to show very limited numbers in the sampled streams, except for the South Fork Winchuck (see Appendix C7). However, presence/absence surveys indicate that coastal cutthroat trout are widely dispersed across streams on the ownership. Coastal cutthroat trout populations tend to decrease south of Redwood Creek and are absent south of the Eel River (Gerstung 1997).
- Juvenile chinook salmon are also observed during the summer population estimates. However, juvenile chinook salmon tend to out-migrate from streams on the ownership prior to June. The juvenile dive counts take place in the months of August and September during summer low flow after the majority of chinook salmon smolts out-migrate. Therefore residual populations of chinook salmon counted during the summer dives demonstrate species presence, but cannot be used for population estimates due to their pattern of early season out-migration.

#### **4.3.9 Out-migrant Smolt Trapping**

Trapping for juvenile salmonid out-migrants has been conducted annually on Little River tributary streams since 1999. This project is designed to monitor smolt abundance, size, and out-migration timing, and to examine long term trends in these variables (see Appendix C8 for details). The trapping results are used in conjunction with the summer juvenile population monitoring to estimate over-wintering survival in the streams monitored. The program also assists in identifying factors affecting the timing of smolt emigration and in establishing baseline and long-term abundance trend data for juvenile populations. The results and discussion of population estimates from coho salmon out-migrant trapping during 1999 and 2000 and corresponding previous summers' population estimates (1998 and 1999) are shown in Appendix C8. Overall, the smolt trapping program results indicates that there is a great deal of variability in the number of smolts between Little River tributaries within a single trapping year as well as between years.

#### **4.3.10 Salmonid Spawning Surveys**

No attempts are made by Green Diamond to estimate adult salmonid populations or spawner escapements. However, periodic spawning surveys have been conducted in several streams on Green Diamond's ownership since 1995-6. They are conducted to determine habitat use and relative numbers of spawners of all species as well as watershed conditions during the winter months (see Appendix C9 for details). Due to the limitations of time, water conditions, and weather, spawner surveys tend to be opportunistic rather than at fixed time intervals or fixed reaches. In general, the entire anadromous reach accessible to coho salmon is surveyed. In long anadromous reaches within one stream, the survey may be broken up into sub-reaches that tend to be based on accessibility and/or time available for the survey. Because of these constraints the surveys are somewhat inconsistent from year to year. Sub-reaches within one watershed may or may not be surveyed on the same day or by the same crew. A general description of the sub-reaches for each stream for which spawner surveys have been conducted is provided in Appendix C9.

The spawning surveys conducted in a small number of streams to date provide an indication of habitat use and relative abundance of spawners in those streams surveyed. Salmonid escapement surveys have helped to show that returning adult populations are using the majority of anadromous habitat available in the surveyed streams. Opportunistic surveys looking at chinook and coho escapement may be helpful in examining age structure, sex ratios, migration timing, and hatchery infiltration. However, the number of HPA streams, high flows, and water visibility limit the utility of such surveys in estimating adult escapement.

#### **4.3.11 Headwaters Amphibian Studies and Monitoring**

Green Diamond has conducted distribution and habitat association studies and has initiated a monitoring program for tailed frogs and southern torrent salamanders. A thorough discussion of the specific objectives, methods and results to date is found in Appendix C11.

##### **4.3.11.1 Tailed Frogs**

As described in detail in Diller and Wallace (1999), the distribution and habitat of larval tailed frogs was studied in first and second order watercourses from 1993-1996 (see Appendix C11.1). Seventy-two watercourses were studied to relate habitat variables to the presence of tailed frogs. From this study, tailed frogs were found to be present and widespread throughout most of the study area. Tailed frogs were found in 75% of the surveyed headwater streams. However, their presence was closely tied to the geological formation of the stream drainage. Data are not available to make direct comparisons of the presence data for tailed frogs within headwater streams to other studies because different sampling procedures were employed. However, estimates of the proportion of streams with tailed frogs varied from 35% in young forests to 96% in old growth areas (Corn and Bury 1989; Welsh 1990; Bull and Carter 1996).

Monitoring of tailed frog populations was initiated in 1997 and will continue under the Plan. The primary approach is a paired sub-basin design. The primary purpose is to compare changes in larval populations of tailed frogs in streams with watersheds where timber harvest occurs (treatment sites) and where it does not (control sites). In

instances where control sites are not available, changes in larval populations will be compared to the amount of timber harvest. In either case, the objective will be to determine if timber harvest activities have a measurable impact on larval populations. Different levels of change in larval tailed frog populations will be used to trigger reviews of management activities (see Section 6). The monitoring reaches within each sub-basin will be sampled at least one year prior to operations that could influence the treatment sites and every year thereafter. New sub-basins will be added across the ownership until there are 12-15 paired sites well distributed across the Plan Area. Depending on the schedule of harvesting in the treatment sub-basins, it will likely be necessary to monitor a site for more than 10 years to determine if a treatment effect has occurred. (See Appendix D for full details of the field protocol.) A secondary monitoring objective will be to document long-term changes in tailed frog populations across Green Diamond's ownership.

Eight paired sub-basins have already been selected. Monitoring began at five paired sub-basin in 1997, at one in 1998, at two more in 1999, and at one more in 2000. Only one treatment monitoring reach has had any significant timber harvest to date. The results to date indicate that there is considerable annual variation within monitoring stream reaches for both control and treatment streams. It also appears that the different sites were somewhat in synchrony such that there were generally good and bad years for tailed frog reproduction. This may be the result of differential annual reproductive effort by the adult population or differences in larval survival among years. Currently, there are many unknowns regarding the adult population in terms of its size or life history characteristics. Therefore it is not possible to determine the cause of these annual fluctuations. In spite of the annual fluctuations in the larval populations, the BACI experimental design that was incorporated in this monitoring program will still allow for the detection of treatment effects since the analysis will be based on a treatment by time interaction. However, these fluctuations will increase the variance in the analysis and therefore decrease the statistically power. As a result, Green Diamond intends to implement additional studies of the adult population to determine if the effects of annual variation can be removed from the analysis through the inclusion of one or more additional covariates.

In conclusion, this study is in its preliminary stages and there has been very little harvesting in any of the treatment sub-basins to date. Therefore, it would be premature to attempt to analyze the data to determine if there were any effects of timber harvest on larval tailed frog populations. However, the data do suggest that there was substantial annual variation in both control and treatment sites which if not explained through future studies of the adult population, may reduce the statistical power of this monitoring approach.

#### **4.3.11.2 *Southern Torrent Salamanders***

As described in detail in Diller and Wallace (1996), the distribution and habitat of southern torrent salamanders in streams of managed forests was studied from 1990-1994 (see Appendix C11.1). The salamanders were located through surveys of first and second order watercourses and incidental searches. Seventy-one headwater streams were studied to relate landscape variables to the presence/absence of southern torrent salamanders. Southern torrent salamanders were found to be present and widespread throughout most of the study area, occurring in 57(80.3%) of the sampled streams. However, southern torrent salamander presence was closely tied to the geological

formation of the stream drainage. Data are not available to make direct comparisons of the presence data for torrent salamanders within headwater streams to other studies because different sampling procedures were employed. However, estimates of the proportion of streams with torrent salamanders have varied from 28.5% in young forests to 86.4% in old growth areas (Carey 1989; Corn and Bury 1989; Welsh et al. 1992).

Monitoring of southern torrent salamander populations was initiated in 1998 and will continue under the Plan. The primary approach is a paired sub-basin design. The primary purpose is to compare changes in sub-populations of southern torrent salamanders in streams with watersheds where timber harvest occurs (treatment sites) and where it does not (control sites). In instances where control sites are not available, changes in sub-populations will be compared to the amount of timber harvest. In either case, the objective will be to determine if timber harvest activities have a measurable impact on the persistence of sub-populations. The objectives of the monitoring program are to determine if there is a difference in the persistence rate for treatment and control sub-populations, and to document any apparent changes in the habitat conditions or index of sub-population size at each site. Different levels of change will be used to trigger reviews of management activities (see Section 6). The monitoring reaches within each sub-basin will be sampled at least one year prior to operations that could influence the treatment sites and every year thereafter. New sub-basins will be added across the ownership until there are 12-15 paired sites well distributed across the Plan Area. Depending on the schedule of harvesting in the treatment sub-basins, it will likely be necessary to monitor a site for more than 10 years to determine if a treatment effect has occurred. (See Appendix D for full details of the field protocol.) A secondary monitoring objective will be to document long-term changes in southern torrent salamander populations across Green Diamond's ownership.

A total of 18 sites in 8 paired sub-basins have already been selected for monitoring southern torrent salamanders. Monitoring began in five of the paired sub-basins in 1998, at two in 1999, and at one more in 2000. As of 2001, there has been no timber harvest immediately adjacent to any of the torrent salamander monitoring sites. The torrent salamander population monitoring protocol is based on the persistence of sites as the primary response variable and not on estimates of abundance of individuals in monitoring reaches. However, the protocol does specify consistent collecting effort over the same sample reach each year so that comparisons of relative abundance of individuals at each site can be made. In spite of the less precise estimate of abundance relative to tailed frogs, there has been little annual variation in the number of torrent salamanders collected at monitoring reaches to date. The mean number of individuals captured per year from 1998-2000 for the 18 sites that were monitored over the entire three years was 11.6, 13.6, and 12.6, respectively. If this pattern persists, it could lend support for using relative abundance as the primary response variable, which would provide much greater sensitivity to the treatment effects for this monitoring approach. In conclusion, this monitoring study is in its preliminary stages and it is too early to determine if there will be any effects of timber harvest on the persistence of the sites by torrent salamanders. Most sites seemed to have relatively constant numbers among years and there is no evidence of any local extinction.

## **4.4 ASSESSMENT OF HABITAT CONDITIONS AND STATUS OF COVERED SPECIES BY HPA**

This section provides an assessment of current habitat conditions and the status of Covered Species on an HPA-by-HPA basis. The assessment identifies similarities and differences in habitat conditions and species occurrence within and among HPAs.

### **4.4.1 Smith River HPA**

#### **4.4.1.1 HPA Type, Size, and Group**

The Smith River HPA is a hydrographic area as defined in this Plan and includes approximately 181,999 acres. It comprises the entire Smith River HPA Group.

#### **4.4.1.2 Eligible Plan Area**

The Eligible Plan Area in the Smith River HPA includes approximately 52,318 acres: 44,177 acres of Initial Plan Area and 8,140 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). Approximately 3,000 acres of the Initial Plan Area were acquired during preparation of the Plan; approximately 41,000 acres are part of the Original Assessment Ownership.

The Initial Plan Area is divided into four areas: 1) the Smith River tract, 2) the Fort Dick and Peacock Creek tracts, 3) the Goose Creek tract, and 4) the Wilson Creek watershed.

- The Smith River tract is in the northern portion of the HPA. It is bounded on the north, for the most part, by the California/Oregon state line. It includes portions of the Winchuck River, which flows into the Pacific Ocean less than a mile north of the state line, and most of the Rowdy and Dominie Creek drainages, which are tributary to the Smith River. Green Diamond's ownership in this area extends across the State border, but the Oregon portion of the Smith River tract is not part of the HPA and is not covered by this Plan.
- The Fort Dick and Peacock Creek tracts are in the northern portion of the HPA and are separated from the Smith River tract. They straddle the Smith River approximately 8 to 10 miles from its mouth. The Fort Dick tract is on the west side of the river, and the Peacock Creek tract is on the east bank. Much of the Fort Dick tract is on the coastal plain and does not drain into the Smith River.
- The Goose Creek tract is in the southeastern portion of the HPA. It is entirely within the Goose Creek drainage, which is tributary to the South Fork of the Smith River. This property is located eight to twelve miles from the coast.
- The Wilson Creek drainage is located in the southwestern portion of the HPA.

#### **4.4.1.3 Geology**

The Smith River HPA includes portions of both the Coast Ranges and Klamath Mountains Geologic Provinces (see **Figure 4-1**). The underlying bedrock of this HPA predominantly consists of Central Belt Franciscan Complex rock, with areas of Klamath Mountains bedrock along the eastern margin of the region. Faults in region include the inactive South Fork Fault, which separates the Franciscan bedrock from the Klamath Mountains bedrock, and a complex network of thrust faults within the Klamath Mountains geology. Scattered, poorly consolidated remnants of Miocene marine sandstone, siltstone and conglomerate deposits (Wimer Formation) overlie the Franciscan bedrock on ridges approximately five miles inland and at elevations of 1200 to 1600 feet above sea level. There are also remnants of continental deposits of sandstone and conglomerate, of similar age, on ridges at slightly higher elevations, near the Wimer Formation deposits. The coastal section of the HPA is dominated by the Smith River Plain, an elevated marine terrace where an abrasion platform of Franciscan rocks is almost entirely covered with a blanket of marine siltstone, shale and unconsolidated sands of Pliocene and Pleistocene age (Battery Formation). Pleistocene to Holocene river terrace deposits, flood plain deposits and dune sands also cover large portions of the Smith River Plain. Unconsolidated Pleistocene to Holocene river terrace and flood plain deposits can also be found at various locations along stream and river channels (Ristau 1979; Davenport 1982-84; Wagner and Saucedo 1987) within the HPA.

Within the HPA, Central Belt Franciscan bedrock composed of Undifferentiated Franciscan Sandstone underlies Green Diamond's northern and southwestern ownership; and Klamath Mountains bedrock composed of serpentinite, gabbro, metavolcanics, and metasedimentary rocks underlies the southeastern ownership.

The topography of the Smith River HPA is highly variable, but in general is relatively steep and sharp-featured compared to other HPAs. Pleistocene and Holocene landslide deposits cover portions of the Franciscan bedrock at numerous locations. Published landslide maps indicate that both shallow and deep-seated landslides exist throughout this HPA with debris slides and disrupted ground present on many slopes (CA DMG 1999). The inherently weak serpentinite of the Klamath Mountains bedrock is also particularly prone to landslide processes, but no known published landslide maps of this area were available for review.

#### **4.4.1.4 Climate**

This HPA is one of the wettest areas of California. Average annual rainfall varies from about 60 inches at Point St. George to over 125 inches at higher inland areas. The precipitation is orographic in nature, increases with elevation, and is usually greater on the windward (southwest) slopes. About 75% of the precipitation occurs between November 1 and March 31 (90% between October 1 and April 30). Average annual snowfall in the unit ranges from 28 inches at elevations of 1700 feet (Elk Valley) to 126 inches at 2420 feet (Monumental). Marine air masses and cold air drainage from higher elevations primarily influence the climate in this area. Occasionally, the climate is influenced by drier air masses associated with east winds.

#### **4.4.1.5 Vegetation**

The Smith River HPA is heavily forested, except for areas on the coastal plain that support agricultural and urban development.

Vegetation in the Initial Plan Area of this HPA is as follows:

- On the Smith River tract and in Wilson Creek, redwood is the dominant component of most cover types. Sitka spruce is a major stand component on coastal aspects, and Douglas-fir is the principal constituent of many stands in the more inland portions of these properties. Western hemlock, western red cedar, and grand fir occur as minor stand components on lower slopes near the coast. Red alder dominates most riparian zones and many lower slopes on north to east aspects throughout this area. Tan oak and madrone are common on drier sites toward the interior, particularly upper slopes with south to west aspects. Stand ages vary from recently planted harvest units to 60 year-old second-growth forests.
- On the Fort Dick and Peacock Creek tracts, the vegetation types are not markedly different from those in the Smith River block, although their more inland location results in less spruce. Younger age-classes also dominate, with few stands over 40 years old in these areas.
- On the Goose Creek tract, the principal forest type is Douglas-fir/tan-oak, with some redwood and Port Orford cedar on lower slopes and along watercourses. It has a cover of interior forest types that reflects far less coastal influence than the other tracts within this HPA. Stands in this area are 30 to 45 years of age, with some scattered older trees throughout the tract that are remnants of the original forest.

#### **4.4.1.6 Current Habitat Conditions**

##### **4.4.1.6.1 Water Temperature**

Water temperature monitoring in the Smith River HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 61 summer temperature profiles were recorded at 25 sites within 16 Class I watercourses. An additional 52 summer temperature profiles were recorded at 20 headwater sites in 22 Class II watercourses. (See Table C5-2 in Appendix C5 for names of watercourses and sites.) Figure 4-5 shows the 7DMAVG water temperature for each monitored site in relation to the square root of the watershed area above that site and in relation to the yellow and red light thresholds of this Plan. Results for the period (1994-2000) indicate that none of Class I sites exceeded the red or yellow light threshold; one Class II site (D1120 TD, a watershed of approximately 71.5 acres) exceeded the yellow light threshold in 2000 with a 7DMAVG of 14.7°C; none of the Class II sites exceeded the red light threshold.

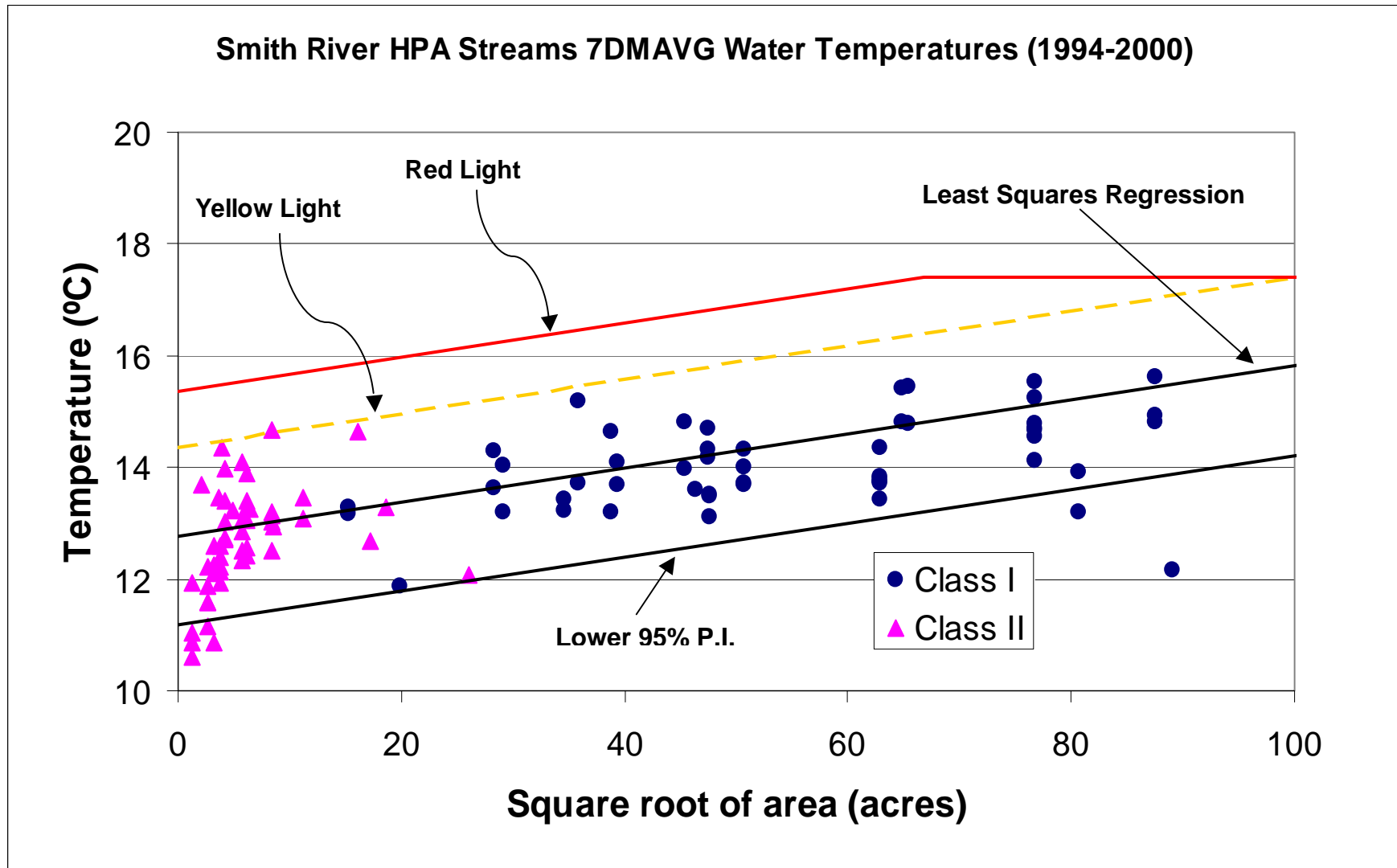
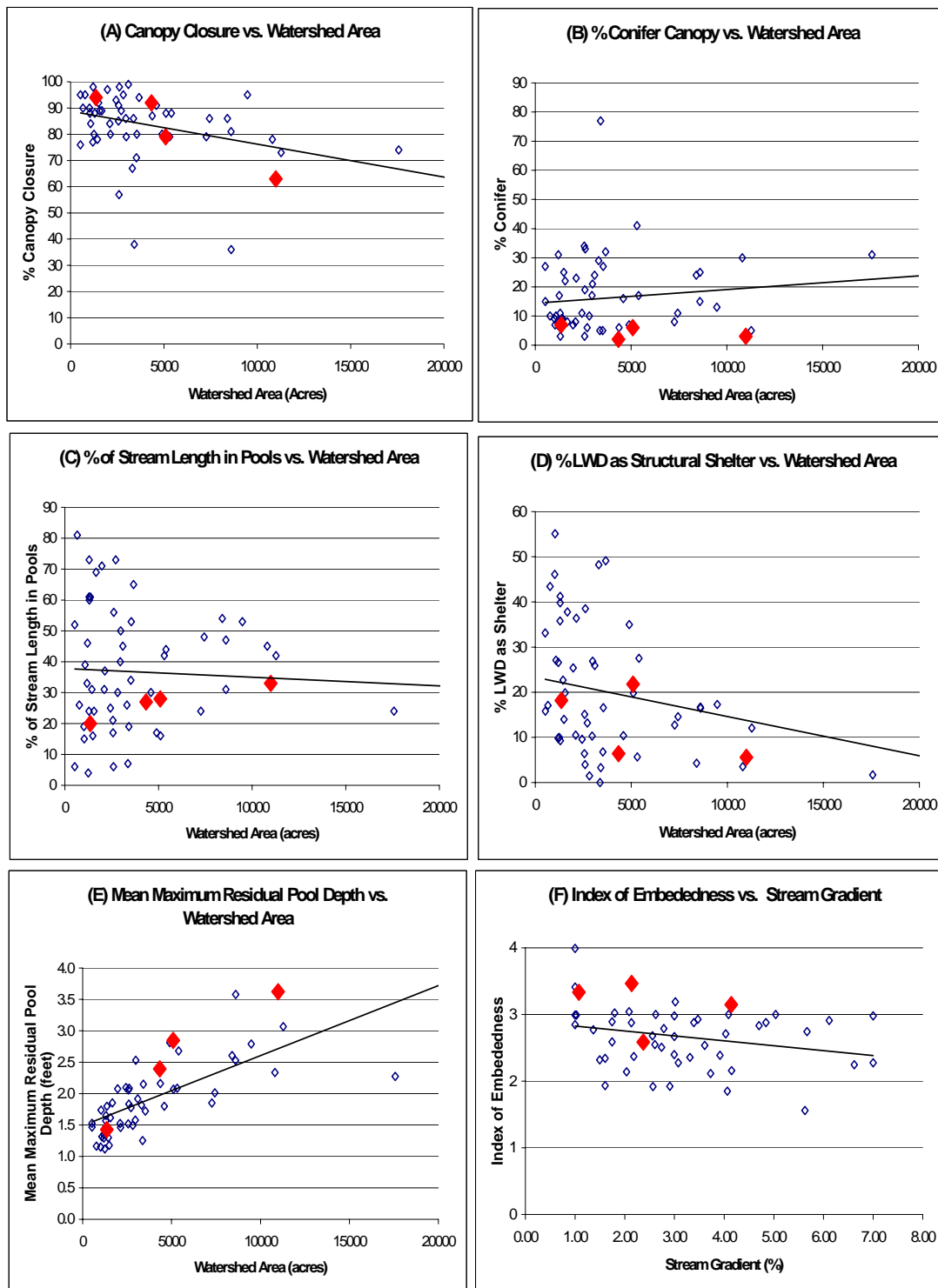


Figure 4-5. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Smith River HPA monitored between 1994 and 2000.



**Figure 4-6.** Channel and habitat types in four streams assessed in the Smith River HPA. (Solid diamonds are assessed streams in Smith River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

#### 4.4.1.6.2 Channel and Habitat Typing

Channel and habitat types were assessed in four streams within the Smith River HPA. The four streams (in descending order of mid-point watershed area), their mid-point watershed area, and their mid-point gradient are as follows:

<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
Dominie Creek	1,356 acres	4.2%
South Fork Winchuck River	4,336 acres	2.1%
Wilson Creek	5,092 acres	1.1%
Rowdy Creek	10,990 acres	2.4%

The results of the assessment surveys are summarized in Figure 4-6 (A-F). See Table C1-2 in Appendix C1 for database, and Section 4.3.1 for summary of methods and assumptions. The least squares regression displayed on the figure was added for comparison purposes only and is not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in this HPA compare with those in other HPAs. The results indicate the following regarding the assessed streams:

- Percentages of canopy closure (63-94%) are somewhat typical compared with all other assessed streams (Figure 4-6 [A]).
- Percentages of conifer canopy (2-7%) are somewhat lower than those for other assessed streams of similar watershed area (Figure 4-6 [B]). Percentage of stream length in pools for three of the streams (20-28%) is considerably lower than that for other assessed streams of comparable watershed area. In the fourth stream (Rowdy Creek), stream length in pools was 33% (Figure 4-6 [C]).
- Percentage of LWD as structural cover in pools for South Fork Winchuck River and Rowdy Creek (6-4%-5.6% respectively) is much less than that for other assessed of streams of comparable watershed area (Figure 4-6 [D]).
- Residual pool depths in three of the streams (2.4 feet to 3.6 feet) are deeper on average than those in other assessed streams of comparable watershed area. In the fourth stream (Dominie Creek), average residual pool depth was 1.4 feet.
- Based on index values for pool embeddedness, all of these streams except Wilson Creek had greater pool tail-out substrate embeddedness than other assessed streams with similar gradients (Figure 4-6 [F]).

In summary, the habitat in the four streams is similar in many instances to that in other assessed streams of similar watershed area. There are, however, some habitat differences. Compared with streams of similar watershed area, the four streams on average have less total linear pool length as a percentage of total stream, are somewhat deeper, have pool tail-outs that are somewhat more embedded, have less LWD as a percentage of structural cover, and their adjacent riparian forest canopy is dominated to a greater extent by deciduous trees.

#### 4.4.1.6.3 LWD Inventory

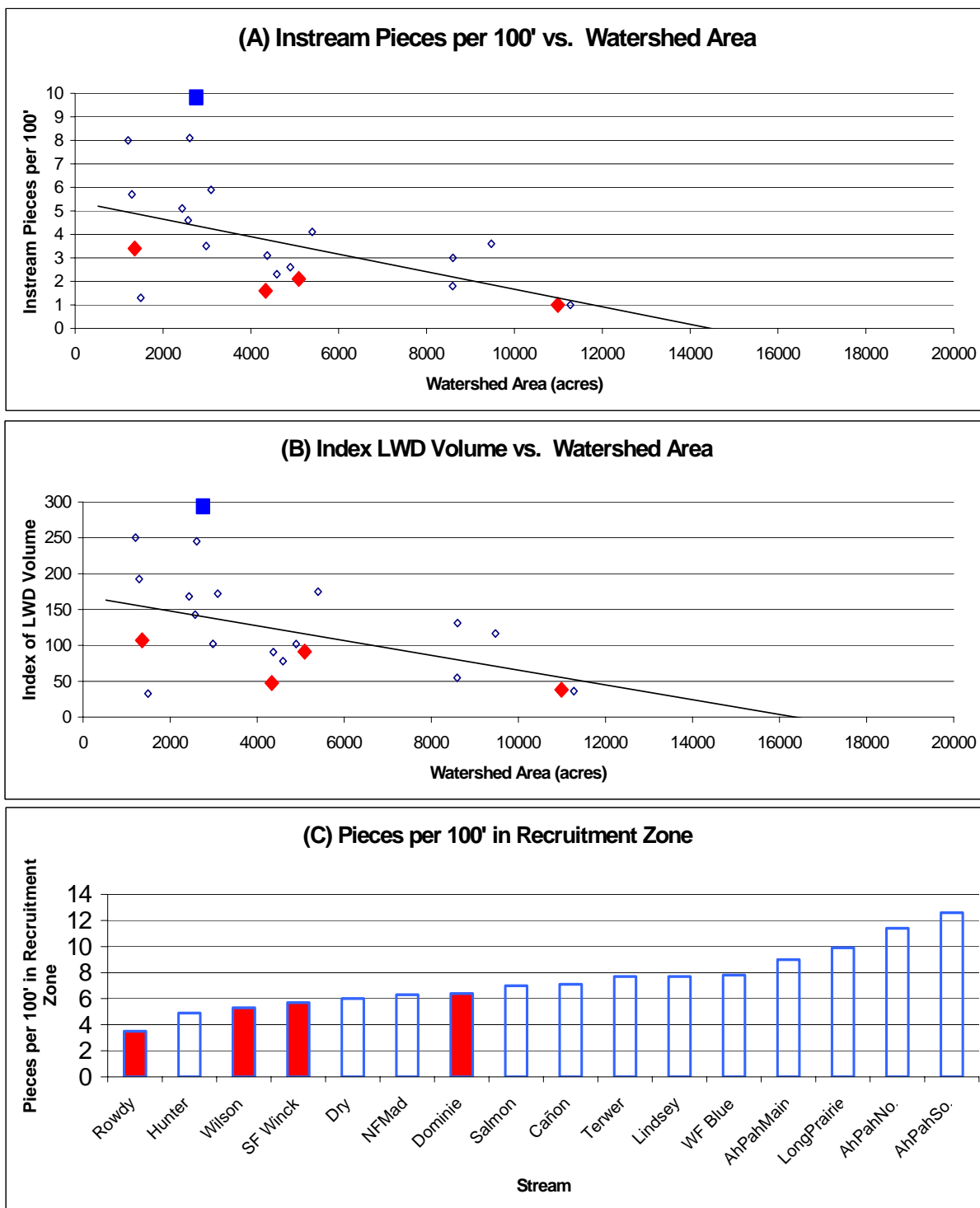
LWD survey/inventories were conducted in 1994 and 1995 in the same four streams where channel and habitat typing assessments were conducted: Dominie Creek, South Fork Winchuck River, Wilson Creek, and Rowdy Creek (see Appendix C2 for details). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment in-stream and riparian LWD.

Results of these investigations are summarized below and depicted in Figure 4-7 (A-C) (see Tables C2-1 and C2-8, C2-15 in Appendix C2 for data). LWD data for Prairie Creek (which is not in this HPA) also are included to provide an additional point of comparison.

- Except for Rowdy Creek, the average number of in-stream LWD pieces per 100 feet of channel was somewhat lower (1.6-3.4 pieces) than that for other assessed streams of similar watershed area (Figure 4-7 [A]). South Fork Winchuck River and Wilson Creek had an average of 1.6 and 2.1 LWD pieces, respectively, per 100 feet of channel, compared with the average of 3-4 pieces per 100 feet for streams with comparable watershed areas (4,000-5,000 acres). In Prairie Creek, the LWD count was approximately 6.8 pieces per 100 feet of channel.
- The LWD volume indices for these streams are shown in Figure 4-7 (B). For Wilson Creek, the LWD volume index is similar to that for all other assessed streams. This is in contrast to the LWD piece count for Wilson Creek and indicates that, although there are fewer pieces per 100 feet of channel, the average size is greater and therefore the volume index is greater. Dominie Creek and South Fork Winchuck had volume indices somewhat lower than the average for streams of comparable watershed area. As a point of comparison, Prairie Creek had a volume index more than twice that for assessed streams of similar watershed area.
- The four assessed streams tended to be on the lower end of the 16 streams where LWD counts were conducted in the riparian recruitment zone (Figure 4-7 [C]). Rowdy Creek had the lowest count of the 16 assessed streams, with an average of 3.5 per 100 feet of recruitment zone.

#### 4.4.1.6.4 Long Term Channel Monitoring

Long term channel monitoring is ongoing in two locations within the Smith River HPA: the South Fork Winchuck River and Wilson Creek. Monitoring began on the South Fork Winchuck in 1996 and on Wilson Creek in 1998. Detailed monitoring objectives and methods are found in Appendix C3. Detailed data analysis has not been completed for streams within this HPA to date. No conclusions can be drawn at this point in the monitoring.



**Figure 4-7.** LWD survey results for four streams assessed in the Smith River HPA. (Solid diamonds are assessed streams in Smith River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)

#### **4.4.1.6.5 Estuarine Conditions**

The estuaries of the rivers within the Smith River HPA have all been altered to some degree by human activity. The extent and impacts of these alterations are unknown.

Winchuck River. The Winchuck River estuary has been impacted by a reduction of habitat through channelization for livestock grazing. The mouth of the Winchuck River regularly bars over during the summer to form an enclosed estuary. This estuary is occupied by juvenile chinook salmon and coastal cutthroat trout during the summer months. The estuary habitat for rearing salmonids is limited due to both a lack of depth and large woody debris for protective cover and avian predator avoidance. Efforts are currently underway by the Oregon Department of Fish and Wildlife (ODFW) to enhance the rearing habitat in the Winchuck River estuary.

Smith River. The lower channel and estuary of the Smith River has been altered and simplified by agriculture, livestock grazing, gravel mining, and urban development. The loss of secondary channels, sloughs, backwaters and large woody debris has reduced the amount and complexity of salmonid rearing habitat. The Smith River mouth generally remains open and does not bar over to form an enclosed estuary.

Wilson Creek. The lower section of this coastal watershed lacks an estuary. The creek runs directly into a semi-protected section of coastline where wave action at the creek's entrance is cushioned by exposed rocks. The lower channel is intermittent during the summer, thus out-migrating smolts have a discrete window in which to leave the watershed.

#### **4.4.1.7 Salmonid Population Estimates**

Population and adult spawner surveys have been conducted in five streams of this HPA (see Appendices C7, C9, and C10 for details). South Fork Winchuck River and Rowdy, Savoy, South Fork Rowdy and Wilson creeks have been monitored for adult returns since 1998. Spawner surveys within these streams are sporadic and often only conducted once in a season. Based on observed returns, no coho have been seen during surveys conducted within the five streams. Chinook salmon have been fairly common and easily distinguished during surveys. Based on late season results, it appears that the available spawning habitat is used by chinook annually in this HPA. Although adult coho have not been observed during spawning surveys, coho juveniles/smolts are found frequently in juvenile dive counts and electrofishing within these streams. Their numbers, however, are very low, which may factor into low observed adult escapement numbers. Steelhead are often seen during late winter surveys in small numbers, however juvenile population estimates within this HPA indicate that adult escapement may be much higher than that indicated from spawner surveys.

#### **4.4.1.7.1 Juvenile Summer Population Estimates**

Figure 4-8 (A-C) summarizes summer population estimates for juvenile coho salmon, steelhead, and coastal cutthroat trout in South Fork Winchuck River and Wilson Creek in 1995 through 2000 (see Appendix C7).

- As shown in Figure 4-8 (A), the annual estimate of juvenile coho salmon in Wilson Creek has varied widely from less than 20 to nearly 1,400 juveniles during the years 1995-2000. The annual coho estimates for South Fork Winchuck also have been variable, with no juvenile coho observed in this stream during the 1999 and 2000 surveys. Overall, coho estimates in South Fork Winchuck River have been much lower than those for Wilson Creek during 1995-2000.
- Annual juvenile steelhead population estimates for Wilson Creek and South Fork Winchuck are highly variable, ranging from a few hundred to over 3,000 during the monitoring period (Figure 4-8 [B]). No pattern in population variation is apparent from the Wilson Creek estimates.
- Coastal cutthroat trout population estimates in the South Fork Winchuck during the years 1996 through 2000 have remained somewhat stable at approximately 400 to 500 juveniles (Figure 4-8 [C]). Population estimates in Wilson Creek have indicated that coastal cutthroat trout populations may not be as stable as those in the South Fork Winchuck. In Wilson Creek, no coastal cutthroat trout were observed in 1997 and 1999, and estimates have ranged from less than 20 to approximately 160 in other years.

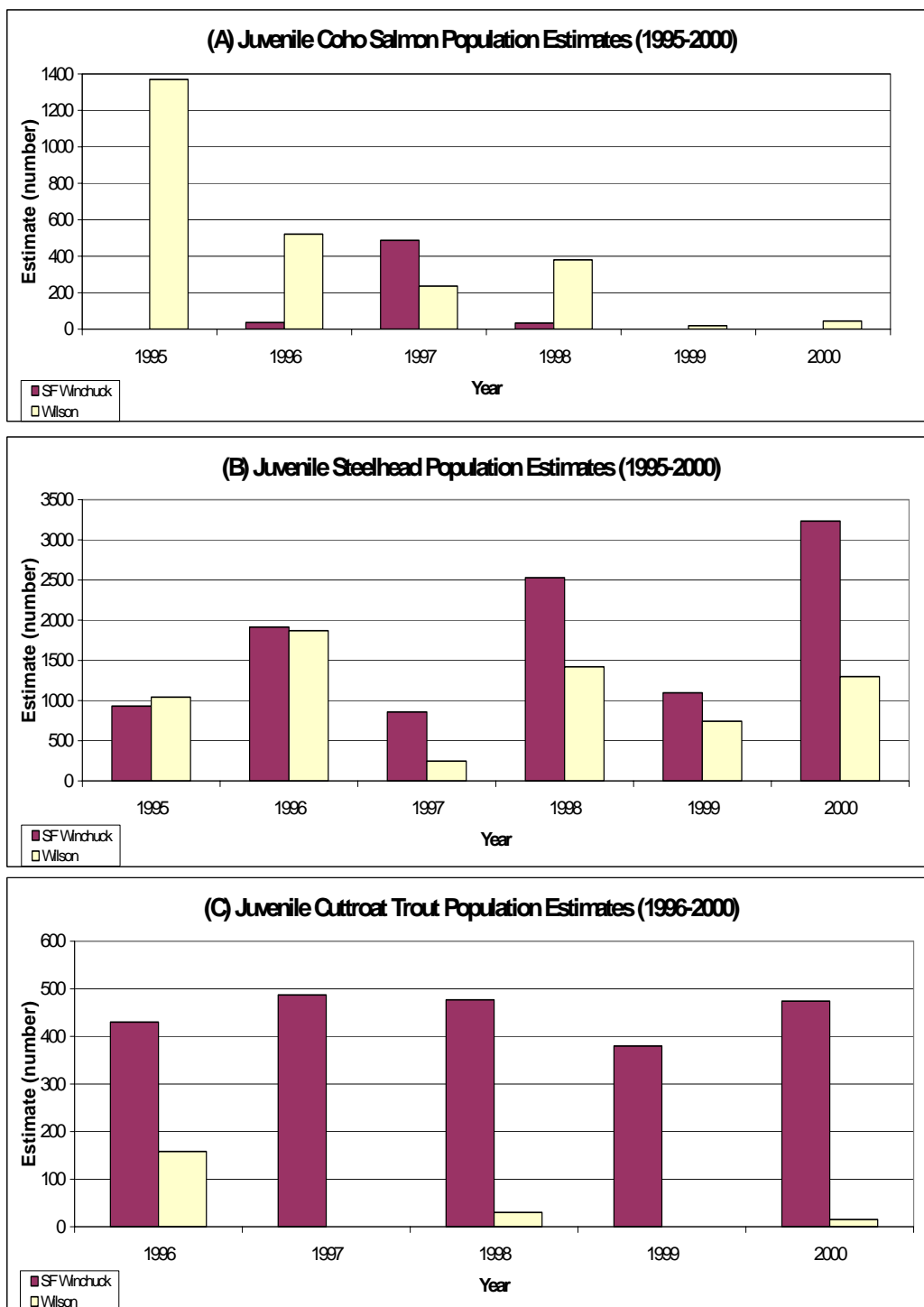
In summary, there is significant variability in annual population estimates for all salmonids monitored in the two Smith River HPA streams. The exceptions were that the cutthroat trout populations in South Fork Winchuck seem to be stable. In addition, there has been an apparent increase of juvenile steelhead in the South Fork Winchuck River and a decrease in juvenile coho populations in Wilson Creek during the survey period.

#### 4.4.1.7.2 Adult Spawner Surveys

Spawning surveys have been conducted on five streams within the Smith River HPA during the period of 1998 through 2000 (see Appendix C9 for details). The streams and years surveyed are:

- South Fork Winchuck River: 1998-9
- Rowdy Creek: 1998-9
- Savoy Creek: 1999-2000 and 1998-9
- South Fork Rowdy Creek: 1999-2000 and 1998-9
- Wilson Creek: 1999-2000

The results to date confirm that chinook salmon are using all of these streams surveyed with the possible exception of Wilson Creek. No live chinook salmon, redds, or carcasses were observed in Wilson Creek during the 1999-2000 spawner surveys. Steelhead were confirmed in only the South Fork of the Winchuck River during these surveys. However, steelhead redds may have been among the many unknown redds observed in the surveyed streams.



**Figure 4-8. Summary of the summer juvenile salmonid population estimates for the years 1995 through 2000 for South Fork Winchuck River and Wilson Creek in the Smith River HPA.**

#### **4.4.1.8 Covered Species Occurrence and Status**

Information regarding the presence or absence of Covered Species in the Smith River HPA is summarized by drainage in Table 4-4. **Figure 4-9** shows the recorded distribution of species in the HPA.

##### **4.4.1.8.1 Chinook Salmon**

The Smith River HPA includes the Southern Oregon and Northern California Coastal Chinook ESU, which was determined to not warrant listing by NMFS as of September 1999 (64 FR 50394). Juvenile chinook salmon production is thought to be increasing in the Winchuck River. The Smith River has the only known spring-run chinook population in coastal California. Chinook are well distributed in smaller coastal streams in this ESU, and recent increases in abundance have been noted in these smaller coastal streams (64 FR 50404-5).

##### **4.4.1.8.2 Coho Salmon**

The Smith River HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA on May 6, 1997 (62 FR 24588). Coho populations are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

##### **4.4.1.8.3 Steelhead and Resident Rainbow Trout**

The Smith River HPA includes the Klamath Mountains Province Steelhead ESU, which was determined to not warrant listing as of April 4, 2001 (66 FR 17845). Steelhead populations in the Winchuck River were assessed as “healthy” by ODFW/CDFG (Nickelson et al. 1992), and the USFS (1993 a, b). Smith River fall run steelhead were considered “healthy” by ODFW/CDFG but summer run fish were considered at high risk of extinction by Nehlsen et al. (1991) and as depressed by the USFS (from Busby et al. 1994).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

Table 4-4. Covered Species distribution in the Smith River HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT <sup>1</sup>	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Winchuck River	3	3	3	3	3	3
South Fork Winchuck River	2,3	1,2,3	2,3	2,3	3	3
Salmon Creek	U	U	U	U	U	U
Bear Creek	U	U	U	U	3	3
Gilbert Creek	A	A	2,3	2	3	3
Lopez Creek	A	A	2	2	P	P
Smith River	2	1,2	2	2	P	P
Ritmer Creek	U	U	U	2	3	3
Tryon Creek	P	2	2	2	U	3
Rowdy Creek	2,3	1,2,3	2,3	2,3	3	3
Dominie Creek	3	1,2,3	2,3	2	3	3
Savoy Creek	3	1	2,3	2	3	P
Ravine Creek	A	A	P	P	3	3
Copper Creek	2	1	2,3	3	P	P
Hutsinpillar Creek	U	U	P	P	3	3
Little Mill Creek	2	1,2	2	2	P	P
Sultan Creek	2	2	2	2	P	P
Camp Six Creek	A	A	A	2	U	U
Peacock Creek	2	2	2	2	P	P
South Fork Smith River	2	1,2	2	2	P	P
Goose Creek	2	P	2,3	2,3	3	3
Wilson Creek	2	1,2,3	2,3	2	3	3
<b>Codes</b>  U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT=resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur. 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records						

#### 4.4.1.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations, with the exception of the Rogue and Smith Rivers, which support large and healthy populations (Johnson et al. 1999). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The populations in this HPA are part of that ESU.

The Smith River is considered California's most important producer of coastal cutthroat trout. Cutthroat trout abundance trends in the Smith River increased 1-5% annually from 1982-1998 (Johnson et al. 1999). In addition, smolt abundance in Mill Creek (tributary to the Smith River) has increased from 1994-1997 (Howard and Albro 1997). Habitat in the

Smith River estuary has been substantially degraded, and populations of coastal cutthroat trout in the estuary are very low compared to historical estimates (Gerstung 1997). Smolt counts in the Winchuck River from 1996-1998 show high variation, but the numbers of trapped smolts (1400 to 2800) are encouraging (Johnson et al. 1999).

#### ***4.4.1.8.5 Tailed Frog***

Green Diamond conducted presence/absence surveys for tailed frogs in eight streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Smith River HPA, 8 of 8 (100%) of the sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 27 other streams throughout the HPA either through other types of amphibian surveys or incidental observations. Given this high rate of occurrence and large number of streams known to support the species, tailed frogs streams in the Smith River HPA appear to be in excellent condition.

#### ***4.4.1.8.6 Southern Torrent Salamander***

Green Diamond conducted presence/absence surveys for southern torrent salamanders in seven streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Smith River HPA, 7 of 7 (100%) of the sampled streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 68 other streams throughout the HPA either through other types of amphibian surveys or incidental observations. Given this high rate of occurrence and large number of streams known to support the species, southern torrent salamander streams in the Smith River HPA appear to be in excellent condition.

#### ***4.4.1.9 Assessment Summary***

Due to the coastal influence and high canopy closure on most streams, water temperatures are good in streams on the Original Assessed Ownership in the Smith River HPA. The HPA is geologically stable relative to many of the other HPAs with competent (consolidated) geologic parent material. As a result, stream substrates remain relatively coarse in most streams even if there are greater than optimum levels of sediment inputs. Most Class I watercourses on the Original Assessed Ownership are generally deficient in the larger classes of LWD due to past timber management and active removal programs. This limits both the amount and quality of pool habitat. Because the current canopy on these watercourses is predominately made up of red alder, the potential for future LWD within the timeframe of this Plan is limited.

All of the Covered Species are common on the Original Assessed Ownership in the Smith River HPA, indicating that conditions are at least adequate for most species in most streams. It is not likely that water temperature in streams on the Original Assessed Ownership limits populations of any Covered Species, and temperatures may be optimum for some Covered Species in some streams. There is ample spawning habitat for the salmonid species due to coarse sediment inputs. However, the general lack of pools and LWD suggests that salmonid numbers may be limited by the amount and/or quality of summer and winter rearing habitat. The abundance of the amphibian Covered

Species in the Original Assessed Ownership in this HPA is consistent with this conclusion, because these amphibians are closely tied to streams with coarse substrate and do not appear to be dependent on pool habitat with LWD for cover.

Assuming these conclusions are correct, the primary management emphasis within the Plan Area of this HPA should be to accelerate the recruitment of future LWD delivery to Class I watercourses. Given the extended time necessary to recruit LWD through natural processes, the Plan Area in this HPA should be evaluated for restoration activities that have the potential to provide short-term increases in quality summer and winter rearing habitats.

#### **4.4.2 Coastal Klamath HPA**

##### **4.4.2.1 HPA Type, Size, and Group**

The Coastal Klamath River HPA is a hydrographic area as defined in this Plan and includes 108,150 acres. It is part of the Coastal Klamath HPA Group.

##### **4.4.2.2 Eligible Plan Area**

The Eligible Plan Area in the Coastal Klamath HPA includes approximately 94,060 acres: 88,760 acres of Initial Plan Area and 5,300 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). Approximately 1,600 acres in the Initial Plan Area were acquired by Green Diamond during preparation of the Plan; approximately 87,100 acres are part of the Original Assessed Ownership.

##### **4.4.2.3 Geology**

The Coastal Klamath HPA is mostly within the Coast Ranges Province, with a sliver of Klamath Mountains Province underlying its northeastern margin (see **Figure 4-1**).

The HPA is predominantly underlain by Central Belt Franciscan Complex bedrock, with Klamath Mountains bedrock underlying the narrow strip along the northeastern margin. The Central Belt Franciscan Complex is generally described as a complex mixture of meta-sandstone and mudstone, with inclusions of other rock types. Klamath Mountains bedrock in the HPA is composed of Josephine Ophiolite intrusive and extrusive volcanics, which includes partially to completely serpentinized ultramafic rocks, gabbro, diorite, pillow lava and breccia. The inactive South Fork Fault separates the Franciscan rocks from the older rocks of the Klamath Mountains geologic province.

The topography of this HPA is highly variable, but in general it is steep and relatively sharp featured. Landslide processes in the HPA are dominated by shallow debris slides and debris flows, based on Green Diamond's preliminary landslide inventory data from this area. These landslides tend to be prevalent on steep slopes along Class I and Class II watercourses and to a lesser extent in the headwall areas of Class III watercourses. Sediment delivered to watercourses from shallow landslides is considered a significant portion of the sediment budget for this hydrologic unit. Deep-seated landslides are relatively uncommon within this HPA, but do exist, as indicated by Green Diamond's preliminary landslide inventory data.

#### **4.4.2.4 Climate**

The large size of the Klamath basin and its geographic differences results in a wide range of climatic conditions. For the entire basin, the weather can be generalized as having dry summers with hot daytime temperatures and wet winters with low to moderate temperatures. Peak air temperatures occur during July with a monthly average maximum of 65°F for the coast and 95°F inland. Precipitation is quite seasonal, with approximately 90% falling between October and March. Annual amounts vary from 20 inches to over 80 inches, depending on location. High intensity rainfall occurs during December-February and may cause flooding at times.

Snow occurs at higher elevations and some areas receive up to 80 inches annually. The highest instantaneous discharge ever recorded in the Klamath River was during the 1964 flood. At the town of Klamath the flow peaked at 650,000 cubic feet per second (cfs) and caused considerable damage. Numerous Klamath River tributaries are still recovering from sediment inputs from this storm event.

#### **4.4.2.5 Vegetation**

The Coastal Klamath HPA is dominated by redwood and redwood/Douglas-fir forests, with Sitka spruce occupying a narrow strip of westerly aspects along the coast and some lower slopes for a short distance inland. The redwood/Douglas-fir forests also include grand fir, western red cedar, and western hemlock on lower slopes and in riparian zones. Red alder is the most common hardwood in riparian zones, and tanoak is the most common mid to upper slope hardwood, with pacific madrone occurring as a minor stand component on drier sites. As distance from the coast increases, the proportion of redwood in stands decreases and Douglas-fir and tanoak become more prevalent. Ridge tops and upper south to west slopes in the most inland reaches can support nearly pure Douglas-fir or tanoak/madrone stands. A distinct ecotone occurs around 2500 to 3000 feet elevation where redwood and Douglas-fir forest rapidly gives way to a non-forest landscape dominated by manzanita, with knobcone pine, ponderosa pine, and Port Orford cedar at the transition and persisting upslope in the bottom of many watercourses. The ecotone is due to a band of serpentinaceous soils on the Red Mountain/Rattlesnake Mountain ridge that divides Terwer Creek and Goose Creek in the Smith River HPA. A few isolated small stands of old growth exist on the Original Assessed Ownership in this HPA, in addition to those in state and federal parks situated within a few miles of the coast. Most of the forests in this HPA were harvested between the 1930s and the 1970s, and stand ages reflect that history.

#### **4.4.2.6 Current Habitat Conditions**

##### **4.4.2.6.1 Water Temperature**

Water temperature monitoring in Original Assessed Ownership in the Coastal Klamath HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 67 summer temperature profiles were recorded at 28 sites within 18 Class I watercourses. An additional 8 summer temperature profiles were recorded at 6 sites within 5 Class II watercourses. Figure 4-10 displays the 7DMAVG water temperature for each monitored site in relation to the square root of the watershed area above that site and in relation to the red and yellow thresholds of this Plan. The results for the period

(1994-2000) indicate that none of Class I or Class II sites exceeded the red or yellow light threshold.

#### 4.4.2.6.2 Channel and Habitat Typing

Channel and habitat types were assessed in 22 streams within the Coastal Klamath HPA. The assessed streams (in descending order of mid-point watershed area, their mid-point watershed area, and their mid-point gradient (%)) are as follows:

<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
Terwer Creek	8,602 acres	1.5%
Tectah Creek	7,424 acres	Not Available
Bear Creek	5,112 acres	3.4%
Hunter Creek	4,896 acres	1.6%
East Fork Terwer Creek	3,523 acres	Not Available
Surpur Creek	2,712 acres	Not Available
Mainstem Ah Pah Creek	2,573 acres	1.7%
North Fork Ah Pah Creek	2,437 acres	2.1%
High Prairie Creek	2,134 acres	3.6%
Tarup Creek	1,971 acres	5.6%
McGarvey Creek	1,672 acres	1.8%
Tributary 2 to Bear Creek	1,442 acres	Not Available
Little Surpur Creek	1,363 acres	4.0%
West Fork McGarvey Creek	1,296 acres	2.7%
South Fork Ah Pah Creek	1,290 acres	4.5%
Tributary 1 to Bear Creek	1,186 acres	4.2%
Tributary to Mainstem Ah Pah Creek	1,076 acres	5.6%
East Fork Hunter Creek	1,031 acres	Not Available
Hoppaw Creek	1,012 acres	1.7%
Omagar Creek	773 acres	3.9%
Mynot Creek	526 acres	Not Available
North Fork Hoppaw Creek	522 acres	3.0%

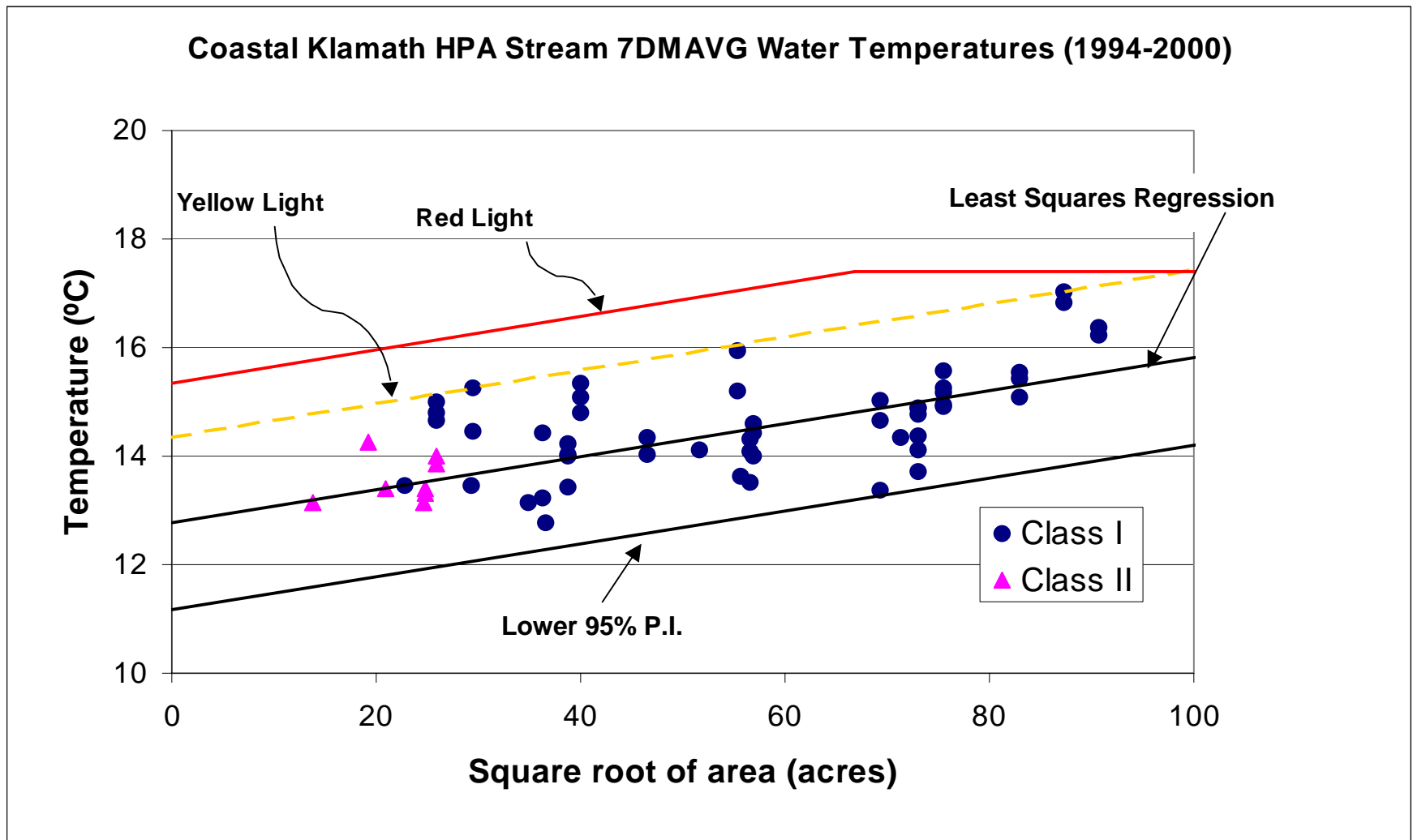


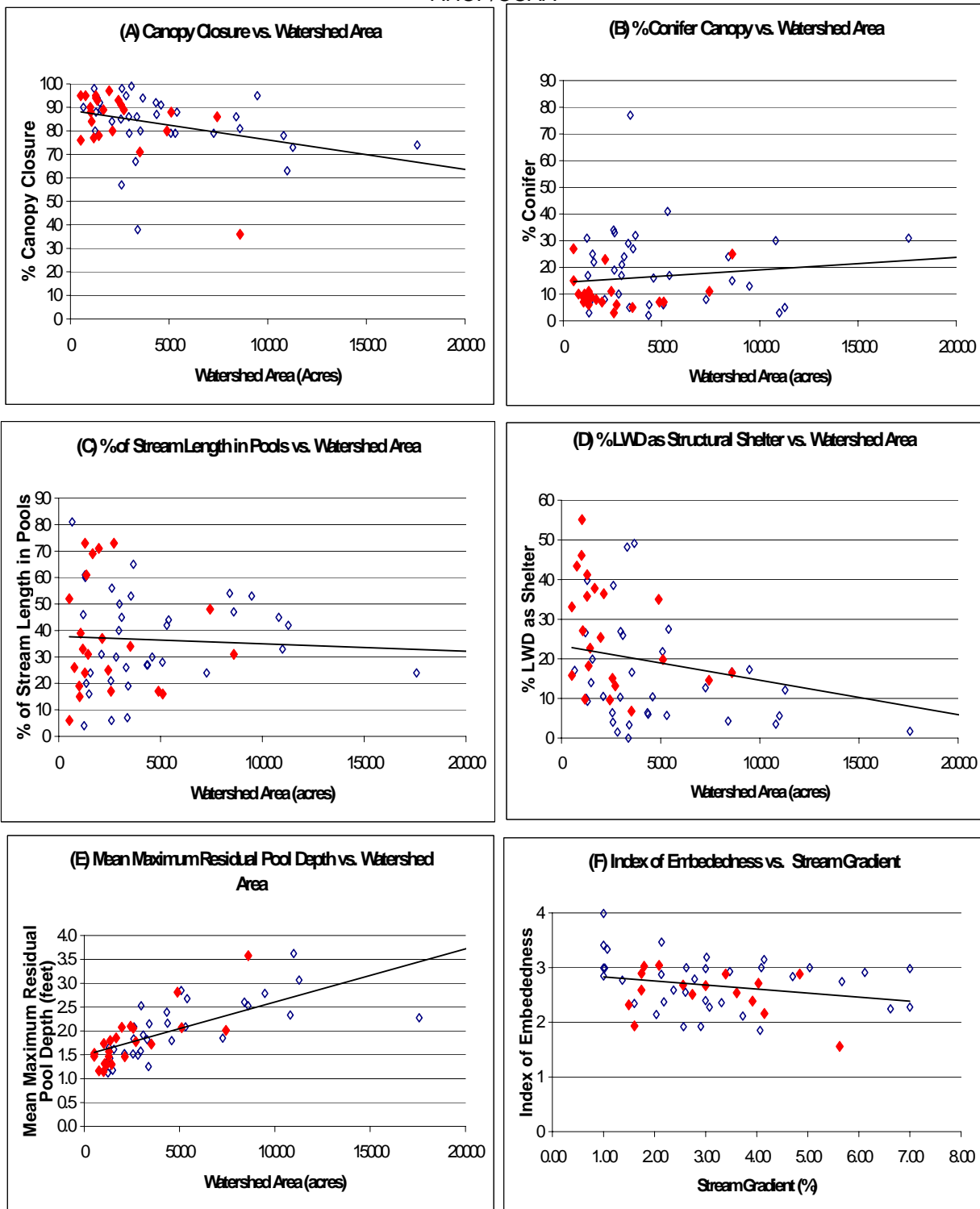
Figure 4-10. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Coastal Klamath HPA monitored between 1994 and 2000.

Six assessments were conducted by Green Diamond, and 16 were conducted by the Yurok Tribal Fisheries Program (see Appendix C1 for details). The results are summarized below and depicted in Figure 4-11(A-F) (see Table C1-3 in Appendix C1 for data). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in this HPA compare with those in other HPAs.

The results indicate the following regarding channel and habitat types in the 22 streams assessed in the Coastal Klamath HPA:

- Except for Terwer Creek, the percentage of canopy closure for these streams (range 71-97%) is somewhat typical of all other assessed streams. (Figure 4-11[A]). Terwer Creek had 36% canopy cover.
- With three exceptions, the 22 assessed streams in this HPA have somewhat lower percentages of conifer canopy (range 3-27%) than assessed streams of similar watershed area in other HPAs (Figure 4-11[B]). North Fork Hoppaw, High Prairie, and Terwer creeks had >20% conifer canopy.
- The percentage of stream length in pools varies widely for the 22 streams, and percentages generally are similar to those for assessed streams in the other HPAs (Figure 4-11[C]).
- The percentage of LWD as structural cover in pools for the 22 streams varies widely, and the percentages are somewhat typical of assessed streams of comparable watershed area in other HPAs (Figure 4-11[D]).
- The residual pool depths measured in the 22 streams vary greatly, and this variation appears similar to that for assessed streams in other HPAs (Figure 4-11 [E]).
- Based on index values for pool tail-out embeddedness, pool tail-out substrate embeddedness for these streams is comparable to that for other assessed streams with similar gradients in other HPAs (Figure 4-11 [F]).

In summary, the habitat in the 22 assessed streams of the Coastal Klamath HPA is in many instances similar to other assessed streams of similar watershed size. However, many of these streams have on average a lower percentage of conifers within adjacent riparian areas and therefore have canopies more dominated by deciduous trees than do other assessed streams of similar watershed area.



**Figure 4-11.** Channel and habitat types in five streams assessed in the Coastal Klamath HPA, (Solid diamonds are assessed streams in Coastal Klamath HPA. Open diamonds are assessed streams in other HPAs. Solid line represents the trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

#### 4.4.2.6.3 LWD Inventory

LWD surveys/inventories were conducted in 1994 and 1995 in five streams within the Coastal Klamath HPA: Hunter, Terwer, North Fork Ah Pah, South Fork Ah Pah, and Ah Pah creeks (see Appendix C2 for details). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD. The summary of the results of these investigations are presented in Figure 4-12 (A-C) (see Tables C2-2 and C2-8 for data). Data for LWD in Prairie Creek also are included to provide an additional point of comparison.

Results indicate the following regarding the LWD inventories for the five assessed streams in the Coastal Klamath HPA:

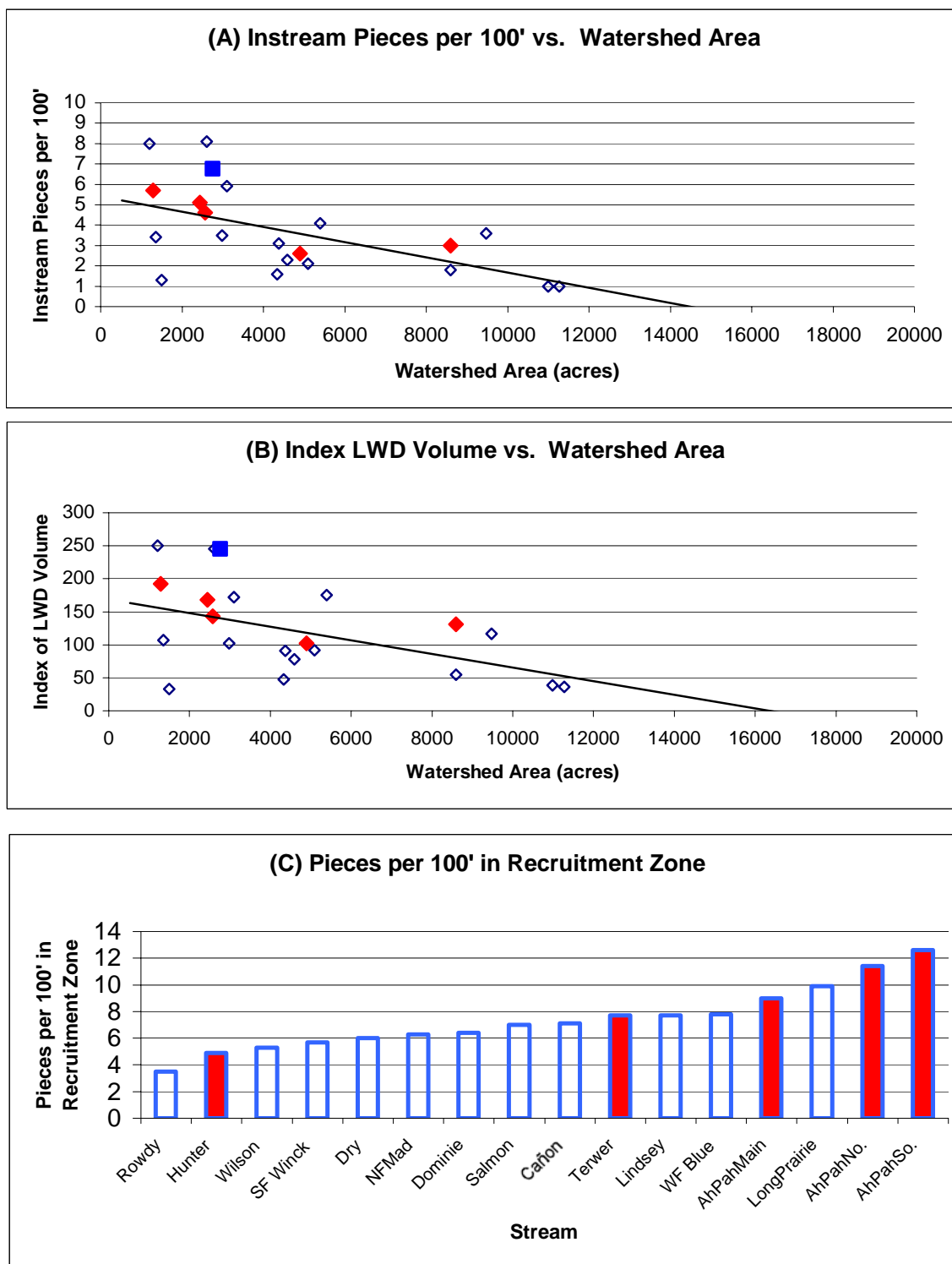
- As shown in Figure 4-12 (A), the average number of in-stream LWD pieces per 100 feet of channel for the five assessed streams (2.6 to 5.7 pieces) is similar to that assessed streams of similar watershed size in other HPAs and lower than the LWD count for Prairie Creek (6.8 pieces per 100 feet of channel).
- As shown in Figure 4-12 (B), the LWD volume indices for these assessed streams are similar to those for other assessed streams of similar watershed area, with the exception of Terwer Creek. Terwer Creek has a greater LWD volume index for its watershed size than the two other assessed streams of comparable watershed area. This indicates that LWD in Terwer Creek has a greater average piece size and therefore the volume index is greater. Prairie Creek had a volume index approximately twice that of assessed streams of similar watershed area.
- The five assessed streams tend to be on the upper end of the 16 streams where LWD counts were conducted in the riparian recruitment zone (Figure 4-12 [C]). South Fork and North Fork Ah Pah and mainstem Ah Pah creeks had three of the four highest average LWD piece counts per 100 feet of recruitment zone of all streams assessed in the 11 HPAs.

#### 4.4.2.6.4 Long Term Channel Monitoring

Channel monitoring is ongoing in four locations within the Coastal Klamath HPA: two sites on Hunter Creek, one on Hoppaw Creek, and one on Tectah Creek. Monitoring began in 1996 on one site in Hunter Creek and in 1997 at the other three sites. (See Appendix C3 for details and data collected.) No conclusions can be drawn at this point in the monitoring.

#### 4.4.2.6.5 Estuarine Conditions

The Klamath River estuary has been impacted by human activities like most north coast watersheds. The lower channel has lost some its wetland habitat to residential development. The estuary has been degraded by excessive sedimentation from the upper basin. The lower channel was also extensively cleared of snags and large woody debris at the turn of the century for commercial gillnetting and navigational purposes.



**Figure 4-12.** LWD survey results for five assessed streams in the Coastal Klamath HPA. (Solid diamonds are the assessed streams in Coastal Klamath HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)

Water diversions from the upper Klamath and Trinity River basins affects the water quality of the estuary during summer months and probably contributes to the occasionally high water temperatures. Even with a large volume of flow, the Klamath River mouth periodically bars over and back floods the lower river for several miles.

#### **4.4.2.7 Salmonid Population Estimates**

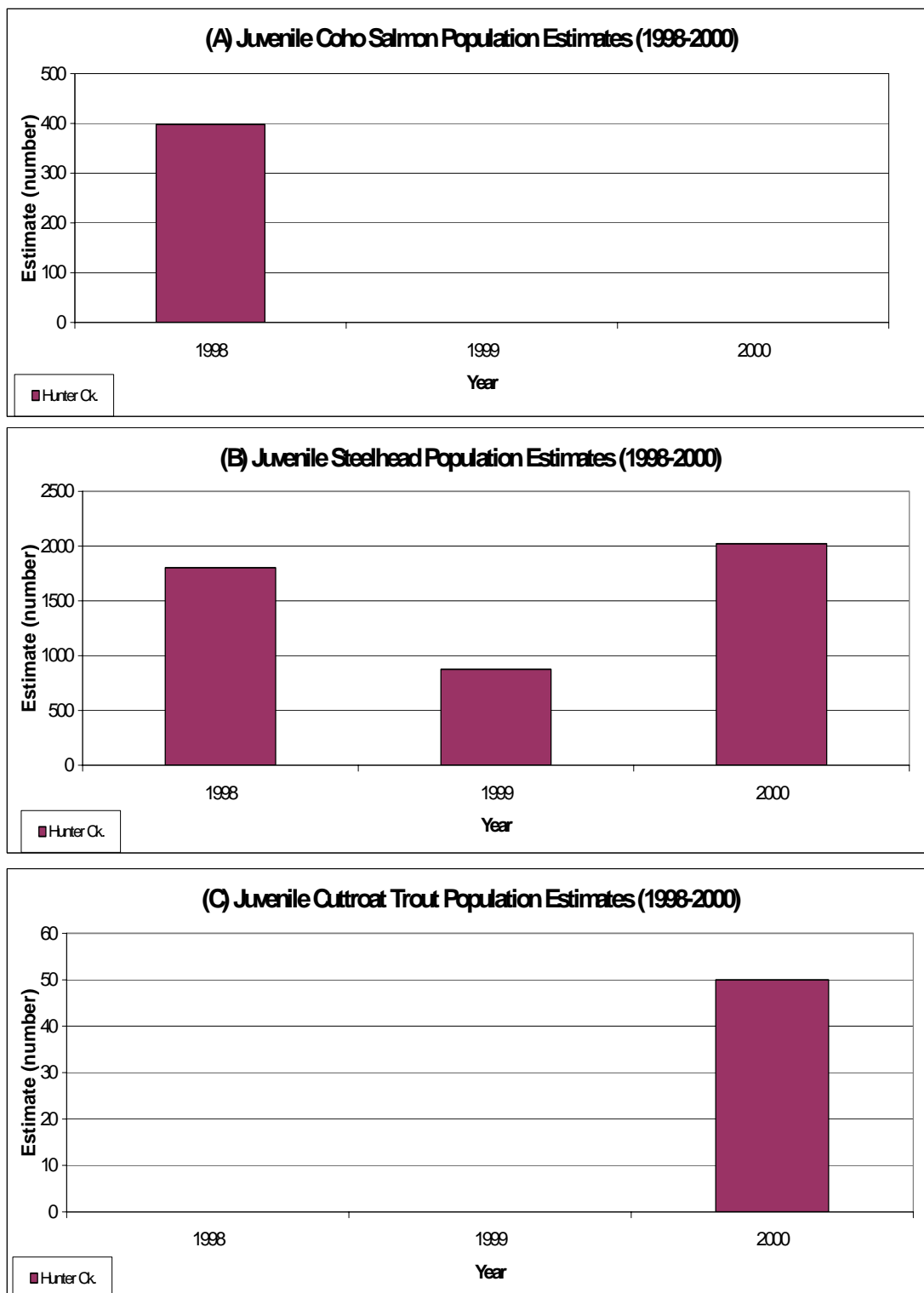
Salmon, steelhead, and coastal cutthroat trout population estimate surveys have been conducted only for Hunter Creek in this HPA; direct observation surveys have been conducted on a number of streams within the Coastal Klamath HPA (see Appendices C7 and C9 for details).

##### **4.4.2.7.1 Juvenile Summer Population Estimates**

Figure 4-13 (A-C) summarizes summer population estimates for Hunter Creek conducted in 1998-2000 for juvenile coho salmon, steelhead, and coastal cutthroat trout. As seen in Figure 4-13 (A), the number of juvenile coho salmon in Hunter Creek in 1998 was estimated to be 400 juveniles. Surveys in 1999 and 2000 found no juvenile coho present in the reaches surveyed, and therefore no population estimates could be made for those years. Steelhead population estimates for Hunter Creek ranged from nearly 900 juveniles in 1999 to greater than 2,000 juveniles in 2000 (Figure 4-13 [B]). The number of juvenile coastal cutthroat trout estimated in Hunter Creek in 2000 was 50 (Figure 4-13 [C]). There were no cutthroat present during surveys conducted in 1998 and 1999. In summary, there is variability in annual estimated juvenile steelhead populations in Hunter Creek. However, the juvenile steelhead population appears to be relatively robust and stable. Summer population estimates for coho and cutthroat indicated there are small numbers of juveniles of these species present with some variability in these populations in Hunter Creek.

#### **4.4.2.8 Covered Species Occurrence and Status**

Presence/absence of the six Covered Species in the Coastal Klamath HPA is presented by drainage in Table 4-5, and the recorded distribution of species is displayed in **Figure 4-14**.



**Figure 4-13. Summary of the summer juvenile salmonid population estimates for the years 1998 through 2000 for Hunter Creek in the Coastal Klamath HPA.**

#### 4.4.2.8.1 Chinook Salmon

The Coastal Klamath HPA includes the Southern Oregon/Northern California and Upper Klamath/Trinity Rivers Chinook ESUs. The Southern Oregon/Northern California Chinook ESU was determined to not warrant listing as of September 1999 (64 FR 50394). Within this ESU as a whole, juvenile production is thought to be increasing in the Winchuck River, and the Smith River has the only known spring-run chinook population in coastal California. Chinook salmon are well distributed in smaller coastal streams, and recent increases in abundance have been noted in these smaller coastal streams (64 FR 50404-5). Chinook escapement in the Klamath Basin is greatly reduced from historic estimates, and current escapement levels are dependent on hatchery production (Voight and Gale 1998) (Busby et al. 1996). The Upper Klamath-Trinity Rivers Chinook ESU was determined to not warrant listing in March 1998. These chinook migrate through the Klamath HPA as adults or as out-migrant smolts.

**Table 4-5. Covered Species distribution in the Coastal Klamath HPA.**

<b>Watersheds and Sub-basins</b>	<b>Chinook</b>	<b>Coho</b>	<b>Steelhead and RRT*</b>	<b>Coastal Cutthroat</b>	<b>Tailed Frog</b>	<b>Torrent Salamander</b>
Klamath River	3,4	1,3,4	3,4	3,4	3	3
Hunter Creek	2,3,4	1,2,3,4	2,3,4	2,3,4	3	3
High Prairie Creek	2	1	2	2	U	U
Salt Creek	P	1,2	2	2	A	A
Mynot Creek	3,4	1	2,3,4	2,3,4	3	3
Saugep Creek	3,4	1,2,3,4	2,3,4	2,3,4	P	P
Hoppaw Creek	A	1,2,3,4	2,3,4	3,4	3	3
Waukell Creek	U	1,2	2	2	U	U
Terwer Creek	2,3,4	1,2,3,4	2,3,4	2,3	3	3
Dandy Creek	U	U	P	P	3	P
South Fork Terwer Creek	U	U	P	P	P	3
McGarvey Creek	2,3,4	1,2,3,4	2,3,4	2,3,4	3	3
Tarup Creek	2,3,4	1,3,4	2,3,4	2,3,4	3	3
Omagar Creek	2	1,3,4	2,3,4	2,3,4	3	3
Ah Pah Creek	2	1,2,3,4	2,3,4	2,3,4	3	3
North Fork Ah Pah Creek	A	A	2,3	2	3	3
South Fork Ah Pah Creek	P	1,2,3,4	2,3	2,3	3	3
Bear Creek	P	1,3,4	2,3,4	3,4	3	3
Surpur Creek	2	1,2	2,3,4	2,3,4	3	3
Little Surpur Creek	A	A	2,3,4	P	P	3
Tectah Creek	2,3	1,2,3,4	2,3	2,3,4	3	3
<b>Codes</b>						
U= Unknown (no data available)						
P= Presumed present based on anecdotal information						
A= Presumed absent based on anecdotal information						
RRT= resident rainbow trout						
*= Occurrence of RRT assumed possible in streams where steelhead occur						
1= Present based on NMFS records in 2001						
2= Present based on CDFG Region 1 files						
3= Present based on Green Diamond records						
4= Present based on Yurok Tribal Fisheries Program						

#### 4.4.2.8.2 Coho Salmon

Coho salmon populations are depressed throughout the Southern Oregon/Northern California Coasts Coho ESU, which encompasses the Coastal Klamath HPA. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995). This ESU was listed as threatened in May 1997 (62 FR 24588). Coho salmon runs in the Klamath Basin are greatly diminished from historical estimates and are largely hatchery supported today, although small wild runs exist in some tributaries (Weitkamp et al. 1995). Juvenile coho were present in 8 of 12 tributaries sampled by the Yurok Tribal Fisheries Program within the Coastal Klamath HPA in 1996 (see Table 4-5), but were generally scarce and narrowly distributed within these tributaries (Voight and Gale 1998). The ratio of wild fish to hatchery fish spawning naturally in these tributaries is unknown.

#### 4.4.2.8.3 Steelhead and Resident Rainbow Trout

The Coastal Klamath HPA includes the Klamath Mountains Province Steelhead ESU, which was determined to not warrant listing as of April 2001 (66 FR 17845). Attempts to assess the status of steelhead in this ESU are hampered by a lack of biological information. In general, there has been a replacement of naturally spawning fish with hatchery fish and downward trends in abundance in most populations (Busby et al. 1994). Specific information on steelhead in the Coastal Klamath HPA is limited. The Yurok Tribal Fisheries Program sampling found juvenile steelhead to be well distributed in Coastal Klamath tributaries (100% presence, n=12 tributaries sampled), but no estimates of abundance were made (Voight and Gale 1998). Steelhead populations in the Klamath River as a whole are significant, (summer/fall-run size of 110,000, winter-run size 20,000) but believed to be largely hatchery supported (Busby et al. 1994).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.2.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999). Short-term trends indicate increases in adult abundance in the lower Klamath River and its tributaries (Johnson et al. 1999).

The Yurok Tribal Fisheries Program found juvenile coastal cutthroat trout to be well distributed and relatively abundant in Coastal Klamath HPA tributaries (present in 10 of 12 tributaries sampled). However, the dominance and abundance of (presumably) resident cutthroat in areas above barriers to anadromy could mask declines in anadromous sea-run coastal cutthroat trout populations (Voight and Gale 1998). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### **4.4.2.8.5 Tailed Frog**

Green Diamond conducted presence/absence surveys for tailed frogs in 17 streams within this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Coastal Klamath HPA, 16 of 17 (94.1%) of the sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 26 other streams in the HPA either through other types of amphibian surveys or incidental observations. Given this high rate of occurrence and large number of streams known to support the species, tailed frogs streams in the Coastal Klamath HPA seem to be in excellent condition.

#### **4.4.2.8.6 Southern Torrent Salamander**

Green Diamond conducted presence/absence surveys for southern torrent salamanders in 16 streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Coastal Klamath HPA, 15 of 16 (93.8%) sampled streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 81 other streams in this HPA either through other types of amphibian surveys or incidental observations. Given this high rate of occurrence and large number of streams known to support the species, southern torrent salamander streams in the Coastal Klamath HPA appear to be in excellent condition.

#### **4.4.2.9 Assessment Summary**

Due to the coastal influence and high canopy closure on most streams, water temperatures are generally good throughout the Original Assessed Ownership in the Coastal Klamath HPA. Although the HPA is less subject to deep-seated instability compared with many of the other HPAs, it is highly susceptible to shallow landslides, and some streams have relatively high levels of sediment inputs. In most of the HPA, the steep slopes are composed of relatively competent (consolidated) geologic parent material, so that stream substrates remain coarse in most streams---even those with high sediment inputs. Exceptions are found in some of the more extreme coastal sub-basins, such as Waukell and McGarvey Creeks, where unconsolidated material results in a fining of the bed. The amount and quality of pool habitat in streams on the Original Assessed Ownership in this HPA are generally consistent with assessed streams in other HPAs, but this is probably less than optimum for salmonids. With a few exceptions, most Class I watercourses on the Original Assessed Ownership in this HPA also are generally deficient in the larger classes of LWD due to past timber management and active removal programs. Because the current canopy on these watercourses is predominately made up of red alder, the potential for future LWD within the timeframe of this Plan is limited.

All of the Covered Species are common throughout the Original Assessed Ownership in the Coastal Klamath HPA, indicating that conditions are adequate for most species in most streams. It is not likely that water temperature in streams on the Original Assessed Ownership in this HPA limits populations of any Covered Species, and temperatures may be optimum for some Covered Species in at least some streams. There is ample spawning habitat for the salmonid species in most streams due to coarse sediment

inputs. However, the general lack of pools and LWD suggest that salmonid numbers may be limited by the amount and/or quality of summer and winter rearing habitat. The abundance of the amphibian Covered Species in the Original Assessed Ownership in this HPA is consistent with this conclusion, because these amphibians are closely tied to streams with coarse substrate and do not appear to be dependent on pool habitat with LWD for cover.

Assuming these conclusions are correct, the primary management emphasis within the Plan Area of this HPA should be to accelerate the recruitment of future LWD delivery to Class I watercourses. Given the extended time necessary to recruit LWD through natural processes, the Plan Area in this HPA should be evaluated for restoration activities that have the potential to provide short-term increases in quality summer and winter rearing habitats. In addition, the Plan Area in this HPA should have a high priority for addressing road-related sediment inputs.

#### **4.4.3 Blue Creek HPA**

##### **4.4.3.1 HPA Type, Size, and Group**

The Blue Creek HPA is a hydrologic unit as defined in this Plan and includes 80,303 acres. It is part of the Coastal Klamath HPA Group.

##### **4.4.3.2 Eligible Plan Area**

The Eligible Plan Area in the Blue Creek HPA includes approximately 15,428 acres: 15,393 acres of Initial Plan Area and 35 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

##### **4.4.3.3 Geology**

The Blue Creek HPA is predominantly within the Klamath Mountain Geologic Province, and its western quarter is underlain by Coast Ranges geology (see **Figure 4-1**). The majority of the Blue Creek HPA (i.e., the central and eastern areas of the unit) is underlain by Klamath Mountains bedrock. The bedrock in the remaining portion of the HPA is composed of Franciscan Complex rocks. The inactive South Fork Fault separates the Coast Ranges Province from the Klamath Mountains Province.

This HPA is primarily underlain by Franciscan Complex rocks. From east to west, the bedrock consists of small patches of partially to completely serpentinized ultramafic bedrock of the Josephine Ophiolite, the South Fork Mountain Schist unit of the Franciscan Eastern Belt, and meta-sandstone and mudstone of the Franciscan Central Belt.

The topography of the Blue Creek HPA generally is characterized by steep terrain and is similar to the steep topography within the Coastal Klamath HPA. Elevations and slope gradients increase toward the east of the HPA in the bedrock of the Klamath Mountains province. Specific data on landslides in this HPA were unavailable for review, but it is thought that landslide processes in this hydrologic unit are dominated by shallow debris slides and debris flows in the Klamath terranes, and there is also considerable potential for deep-seated landslides within this HPA.

#### **4.4.3.4 Climate**

Precipitation in the Blue Creek headwaters averages 100 inches annually, 75% of which falls between November and March (Helley and LaMarche 1973, as cited in YTF Tech. Rep. #4 1998). The seasonal nature of the precipitation leads to large seasonal variations in stream flow, ranging from a low of 43 cfs to a high of 33,000 cfs over the period 1965 to 1978. (USGS, unpublished data, as cited in YTF Tech. Re. #4 1998). Air temperatures in the region are mainly affected by the coastal marine climate, with daily high temperatures ranging from 40-70°F annually. During the summer, the climate is moderated by coastal fog which reduces solar radiation and contributes moisture by fog drip.

#### **4.4.3.5 Vegetation**

Blue Creek's elevation range (50 to 5700 feet) and its location at the inland edge of summer fog intrusion provide for a diverse association of forest types. At the mouth of Blue Creek, coastal redwood/Douglas-fir forest predominates, and redwood persists nearly to Green Diamond's property line, approximately 7 miles upstream. Six Rivers National Forest owns the entire HPA above Green Diamond's property, and the forest there progresses from Douglas-fir/tanoak at lower elevations to a montane conifer forest more typical of the Klamath Mountains at higher elevations, with Douglas-fir and white fir the primary overstory species. As in the Coastal Klamath HPA, serpentine soils on South Red Mountain generate a vegetative cover type above 2500 to 3000 feet that is dominated by manzanita, with knobcone pine, ponderosa pine, and Port-Orford-cedar at the transition and persisting upslope in the bottom of many watercourses. This same soil-vegetation complex occupies over much of the Slide Creek subwatershed that is mostly within the National Forest on the south slope of Blue Creek.

Timber harvesting operations began around 1960 in this HPA and by 1990 all but scattered remnants of the original forest on Green Diamond's property had been harvested. Very little timber harvesting has occurred within the 80% of this watershed owned by the National Forest and roughly 40% of that ownership is in the Siskiyou Wilderness Area.

#### **4.4.3.6 Current Habitat Conditions**

##### **4.4.3.6.1 Water Temperature**

Water temperature monitoring in the Blue Creek HPA 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 23 summer temperature profiles were recorded at 7 sites within 7 Class I watercourses. An additional 5 summer temperature profiles were recorded at 3 headwater sites within 2 Class II watercourses.

Figure 4-15 displays the 7DMAVG water temperature for each monitored site in relation to the square root of the watershed area above that site and in relation to the red and yellow thresholds of this Plan. The results for the period (1994-2000) indicate that none of the Class I sites exceeded the red or yellow light thresholds and two of the Class II sites exceeded the yellow light threshold (lower Potato Patch Creek in 1996 and upper Potato Patch in 1997).

#### 4.4.3.6.2 Channel and Habitat Typing

Channel and habitat typing assessments have been conducted in four streams in the Blue Creek HPA. The assessments were conducted by the Yurok Tribal Fisheries Program. The four assessed streams (in descending order of mid-point watershed area), their mid-point watershed area, and their gradient are as follows:

<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
Blue Creek	38,563 acres	2.0%
West Fork Blue Creek	4,372 acres	6.1%
Slide Creek	3,414 acres	6.6%
Potato Patch Creek	2,820 acres	5.7%

The results of the assessments for West Fork Blue Creek, Slide Creek, and Potato Patch Creek are summarized below and in Figure 4-16 (A-F) (see Table C1-4 in Appendix C1 for data). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs. Assessment results for Blue Creek are not presented in Figure 4-16 (A-E) because the watershed area for this stream is greater than 38,000 acres but are included in the analysis of gradients in Figure 4-16 (F). The results for the assessed streams in this HPA indicate the following:

- Compared with other assessed streams in the 11 HPAs, Slide Creek has a much lower percentage canopy closure (38%) than did all but one other stream regardless of watershed area (Figure 4-16 [A]). However, the canopy cover in Slide Creek consists of 77% conifer, a much greater percentage than in other assessed streams (Figure 4-16 [B]).
- West Fork Blue, Slide, and Potato Patch creeks has a somewhat lower percentage of stream length in pools than other assessed streams with similar watershed area (Figure 4-16 [C]). Also, the percentage of LWD as structural cover in pools in these streams is lower than in almost all other assessed streams of comparable watershed area (Figure 4-16 [D]). The average residual pool depths in these three streams are shallow (1.5 feet to 2.2 feet) but appear to be similar to other assessed streams of similar watershed area (Figure 4-16 [E]).
- Substrate embeddedness indices for the all four assessed streams in this HPA are somewhat variable, and three of the streams had a much greater gradient than most other assessed streams in the HPAs (Figure 4-16 [F]). Blue Creek was included in the analysis of embeddedness in relation to stream gradient, and the results indicate that this stream has a rather low index of substrate embeddedness (see Figure 4-16 [F]).

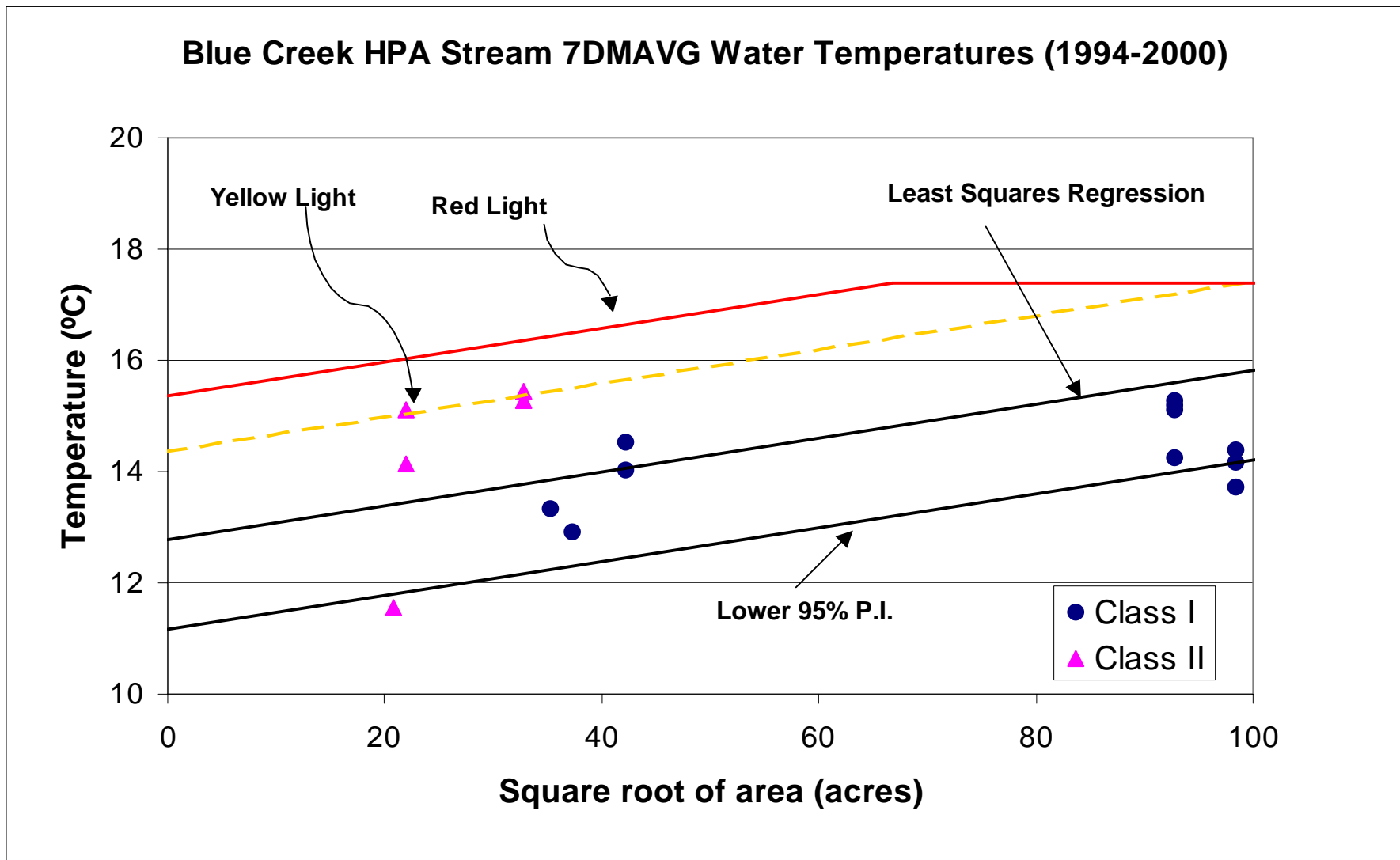
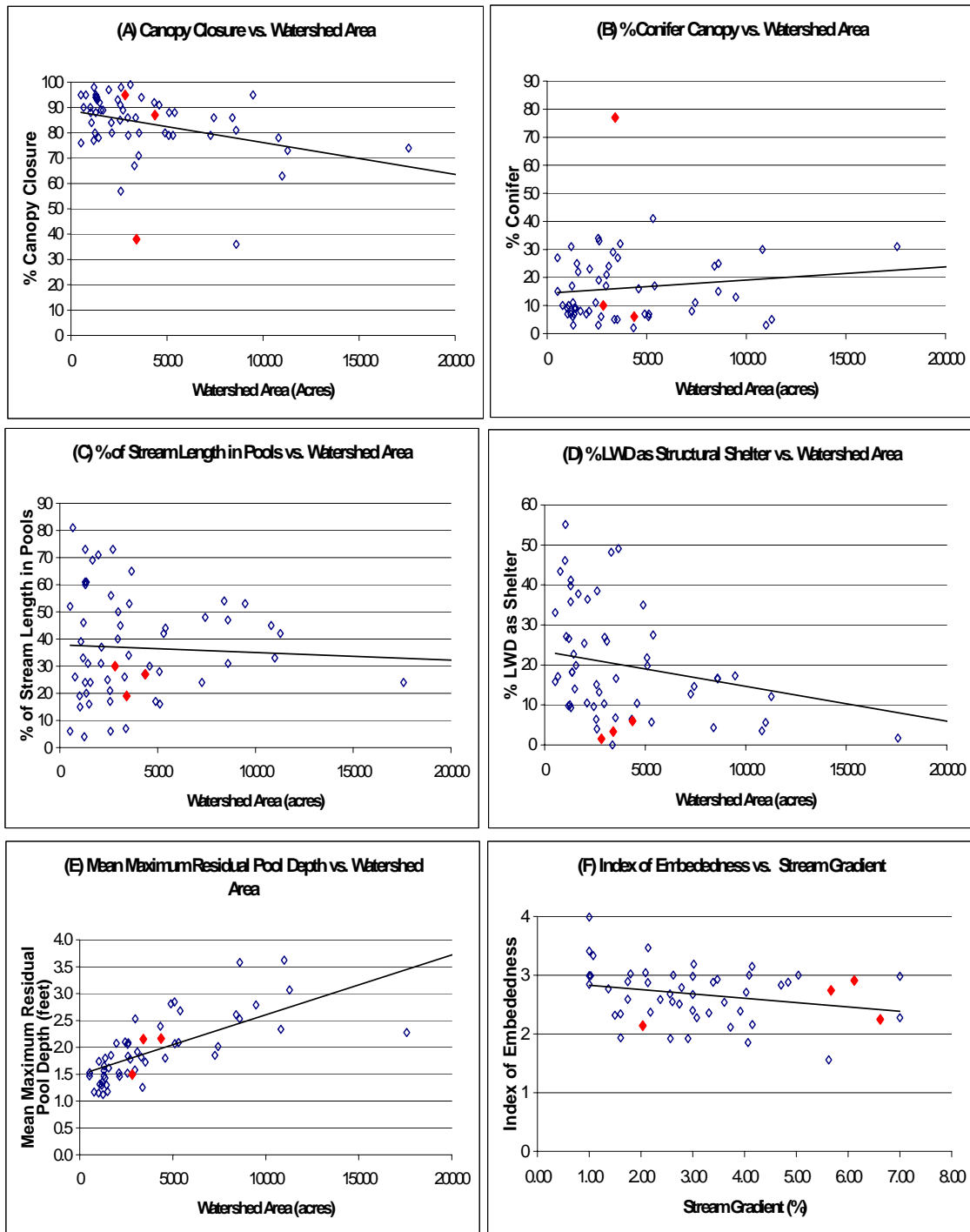


Figure 4-15. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Blue Creek HPA monitored between 1994 and 2000.



**Figure 4-16.** Channel and habitat types in streams assessed in the Blue Creek HPA. (Solid diamonds are assessed streams in Blue Creek HPA; Blue Creek not included in A-E. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

In summary, these results suggest that the habitat in the assessed streams in this HPA in many instances is similar to that in other assessed streams of similar watershed area. There are, however, some habitat differences. West Fork Blue, Slide, and Potato Patch creeks on average had a lower percentage of stream length in pools, and their pools contained lower percentages of LWD as cover structure than most of the other assessed streams. All four assessed streams also had greater stream gradients than most other assessed streams on the Original Assessed Ownership.

#### **4.4.3.6.3 LWD Inventory**

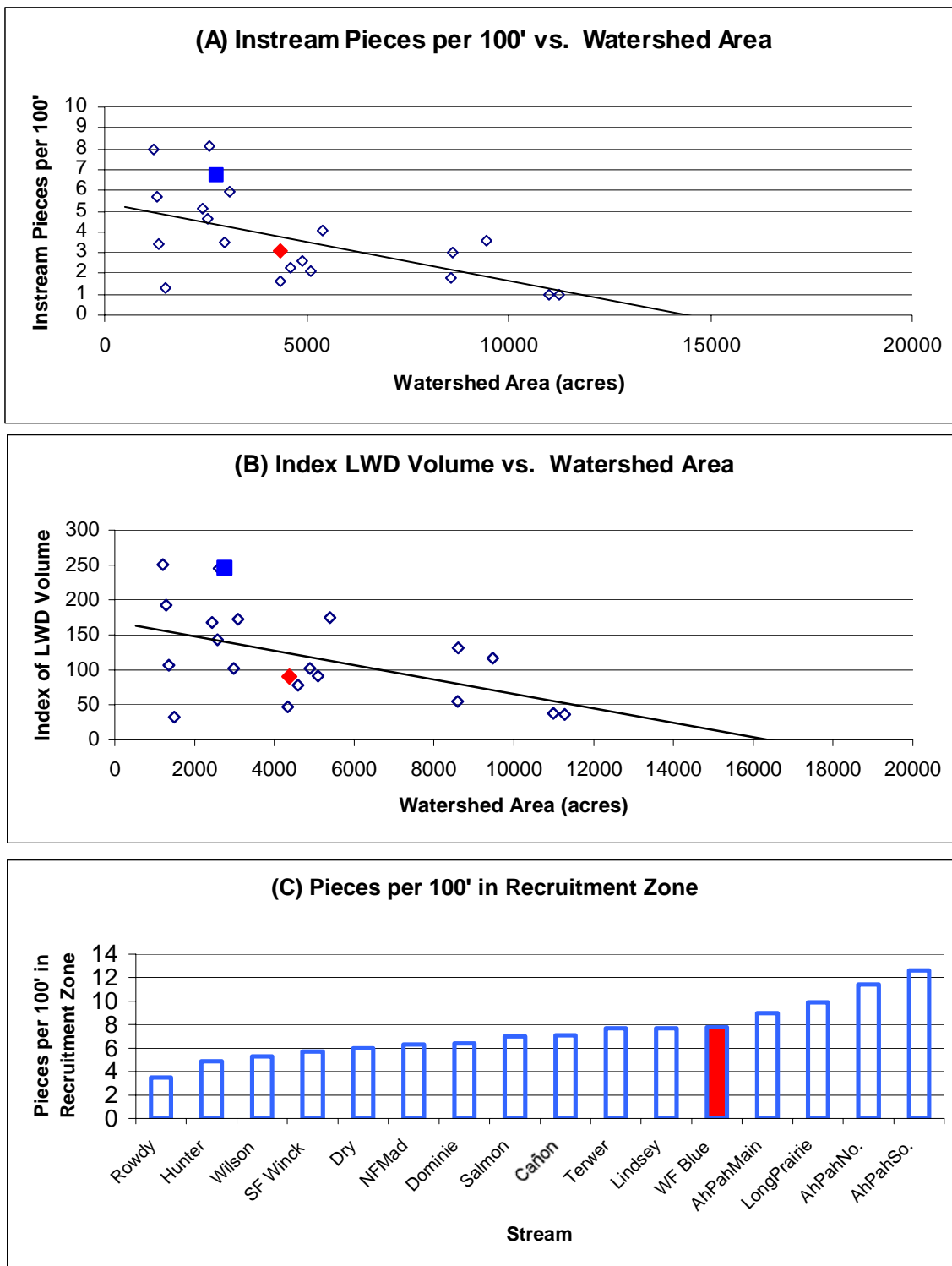
LWD survey/inventories were conducted in 1994 and 1995 in 1 stream (West Fork Blue Creek) within the Blue Creek HPA (see Appendix C2). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of in-stream and riparian LWD.

Results of the assessment are summarized below and displayed in Figure 4-17(A-C) (see Tables C2-3 and C2-9 in Appendix C2 for data).

- As shown in Figure 4-17 (A) the average number of in-stream LWD pieces per 100 feet of channel for West Fork Blue Creek is somewhat greater than in other assessed streams with similar watershed area. The average number of LWD pieces per 100 feet of channel for West Fork Blue Creek was approximately 3.1 pieces. However, this is less than one-half of the LWD count in Prairie Creek (6.8 pieces per 100 feet of channel).
- The index volume of LWD for West Fork Blue Creek is shown in Figure 4-17 (B). The index is similar but somewhat greater than that for other assessed streams of similar watershed area. Prairie Creek had a volume index approximately twice that for all assessed streams of similar watershed size and almost 3 times that for West Fork Blue Creek.
- As shown in Figure 4-17 (C), West Fork Blue Creek is on the upper end of the set of the 16 streams assessed for LWD in the riparian recruitment zone. The average number of LWD pieces per 100 feet of recruitment zone in West Fork Blue Creek is determined to be 7.7 (see Figure 4-17 [C]). This piece count is similar to that for Terwer Creek in the Coastal Klamath HPA and Lindsey Creek in the Mad River HPA.

#### **4.4.3.7 Salmonid Population Estimates**

Salmonid population surveys have not been conducted in the Initial Plan Area of this HPA.



**Figure 4-17.** LWD survey results for one stream assessed in the Blue Creek HPA. (Solid diamond is West Fork Blue Creek. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)

#### 4.4.3.8 Covered Species Occurrence and Status

Presence/absence of the six Covered Species in the Blue Creek HPA is presented by drainage in Table 4-6; the recorded distribution of the species is shown in **Figure 4-18**.

##### 4.4.3.8.1 Chinook Salmon

The Blue Creek HPA is in the Southern Oregon and Northern California Chinook ESU, which was determined to not warrant listing as of September 1999 (64 FR 50394). In this ESU as a whole, juvenile production is thought to be increasing within the Winchuck River, and the Smith River has the only known spring-run chinook population in coastal California. Chinook salmon are well distributed in smaller coastal streams, and recent increases in abundance have been noted in these smaller coastal streams (64 FR 50404-5).

Blue Creek chinook populations have been monitored by the USFWS (1988 to 1992) and are currently monitored by the Yurok Tribal Fisheries Program. Chinook escapement in the Klamath Basin is greatly reduced from historic estimates. Blue Creek has a significant but variable chinook salmon population which has shown an increasing trend of adult escapement and juvenile out-migrant abundance during the period from 1988 through 1996. (Gale et al. 1998) (Busby et al. 1996). Compared with other non-hatchery supported tributaries of the Klamath basin with similar drainage areas, Blue Creek is thought to contribute a significant component to the wild chinook run within the Klamath River (Gale et al. 1998).

**Table 4-6. Covered Species distribution in the Blue Creek HPA.**

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Klamath River	2,3,4	1,2,3,4	2,3,4	2,3	3	3
Blue Creek	2,3,4	1,2,3,4	2,3,4	2,3,4	3	3
Pularvasar Creek	U	1,3,4	2,4	P	P	3
One Mile Creek*	3,4	1,3,4	3,4	3,4	4	P
West Fork Blue Creek	2,3	1,2	2,4	P	3	3
Potato Patch Creek	A	1	2	P	3	3
Coyote Creek	U	U	U	U	3	3
Indian Creek	U	U	U	U	3	3
Slide Creek	A	A	2,3,4	P	P	P
Nickowitz Creek	4	1	2,3,4	P	P	P
<b>Codes</b>  U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT= resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records 4= Present based on Yurok Tribal Fisheries Program						

#### 4.4.3.8.2 Coho Salmon

The Blue Creek HPA includes Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened in May 1997 (62 FR 24588). Coho salmon populations are depressed throughout this ESU, and current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

The Blue Creek HPA is somewhat unusual in that it supports a significant population of native coho salmon with no evidence of hatchery produced fish in a river system characterized by heavy hatchery production and planting within many tributaries (Weitkamp et al. 1995, Gale et al. 1998). Estimates of and trends in spawner escapements are hampered by low numbers of spawners and the difficulty in enumerating adult coho salmon, especially during the high flow/poor visibility conditions. Qualitative snorkeling surveys indicate that portions of the Blue Creek HPA (especially the Crescent City Fork) have ideal spawning and rearing habitat for coho, and juvenile coho were observed utilizing this habitat in high densities (Gale et al. 1998).

#### 4.4.3.8.3 Steelhead and Resident Rainbow Trout

The Blue Creek HPA includes the Klamath Mountains Province Steelhead ESU, which was determined to not warrant listing in April 2001(66 FR 17845). Attempts to assess the status of steelhead in this ESU are hampered by a lack of biological information. In general, there has been a replacement of naturally spawning fish with hatchery fish, and downward trends in abundance in most populations (Busby et al. 1994).

The Blue Creek HPA has ideal habitat for steelhead and is thought to contain a large population of winter-run steelhead as well as a small number of summer-run steelhead. Snorkel surveys found juvenile steelhead to be abundant and well distributed throughout Blue Creek (Gale et al. 1998).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.3.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined not warrant listing (64 FR 16397). The population in this HPA is a part of that ESU.

Short-term trends indicate increases in adult abundance in the lower Klamath River and its tributaries (Johnson et al. 1999). The Yurok Tribal Fisheries Program reports that Blue Creek supports a small population of coastal cutthroat trout (Gale et al. 1998).

#### **4.4.3.8.5 Tailed Frog**

Green Diamond conducted presence/absence surveys for tailed frogs in three streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Blue Creek HPA, 2 of 3 (66.7%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 7 other streams in the HPA either through other types of amphibian surveys or incidental observations.

A relatively small portion (19.2%) of the HPA is Green Diamond's ownership, so it is difficult to extrapolate from Green Diamond's studies to the entire HPA. However, this HPA appears very similar to the Coastal Klamath HPA, which appears to have excellent habitat for tailed frogs. The limited data collected are not inconsistent with this conclusion, and Green Diamond concludes that tailed frogs streams in the Blue Creek HPA are also likely to be in excellent condition.

#### **4.4.3.8.6 Southern Torrent Salamander**

Green Diamond conducted presence/absence surveys for southern torrent salamanders in four streams in this HPA. The surveys were part of a sampling of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Blue Creek HPA, 4 of 4 (100%) streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 32 other streams in this HPA either through other types of amphibian surveys or incidental observations.

A relatively small portion (19.2%) of the HPA is in Green Diamond's ownership, so it is difficult to extrapolate from Green Diamond's studies to the entire HPA. However, this HPA appears very similar to the Coastal Klamath HPA, which appears to have excellent habitat for torrent salamanders. The limited data collected are consistent with this conclusion, and Green Diamond concludes that southern torrent salamander streams in the Blue Creek HPA are also likely to be in excellent condition.

#### **4.4.3.9 Assessment Summary**

Water temperatures are generally good throughout the Original Assessed Ownership in the Blue Creek HPA. The fact that some Class II watercourse reaches had water temperatures at the yellow light threshold is an indication of warmer summer temperatures in this interior region. The geologic parent material is apparently relatively well-consolidated, resulting in generally coarse stream substrates in the region. Within the Original Assessed Ownership in this HPA, Class I watercourses are generally deficient in LWD; but due to the small portion (19.1%) of the HPA in Green Diamond's ownership, it is not known if this applies to the entire HPA.

All of the Covered Species are relatively common throughout the Original Assessed Ownership in the Blue Creek HPA, indicating that conditions are adequate for most species in most streams. It is not likely that water temperature in streams on the Original Assessed Ownership limits populations of any Covered Species even though two Class II watercourse reaches had temperatures that reached the yellow light threshold. This conclusion is based on the presence of both of the amphibian Covered

Species in the stream for which the yellow light threshold was recorded. There is ample spawning habitat for the salmonid species in most of the streams due to coarse sediment inputs. However, the general lack of pools and LWD suggest that salmonid numbers may be limited by the amount and/or quality of summer and winter rearing habitat. The abundance of the amphibian Covered Species in the Original Assessed Ownership in this HPA is consistent with this conclusion, because these amphibians are closely tied to streams with coarse substrate and do not appear to be dependent on pool habitat with LWD for cover.

Assuming these conclusions are correct, the primary management emphasis within the Plan Area of this HPA should be to accelerate the recruitment of future LWD delivery to Class I watercourses. Given the extended time necessary to recruit LWD through natural processes, the Plan Area of this HPA should be evaluated for restoration activities that have the potential to provide short-term increases in quality summer and winter rearing habitats.

#### **4.4.4 Interior Klamath HPA**

##### **4.4.4.1 HPA Type, Size, and Group**

The Interior Klamath HPA is a hydrographic area as defined in this Plan and includes 128,006 acres. It is part of the Korbel HPA Group.

##### **4.4.4.2 Eligible Plan Area**

The Eligible Plan Area in the Interior Klamath HPA includes approximately 109,357 acres: 66,130 acres of Initial Plan Area and 43,217 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

##### **4.4.4.3 Geology**

Bedrock in this HPA is primarily composed of the Coast Ranges Franciscan Complex, with Klamath Mountains bedrock present in limited areas at the eastern margin (see **Figure 4-1**). The inactive South Fork Fault is the major structural feature in the HPA.

Most of the HPA is underlain by the Franciscan Complex bedrock. The bedrock is roughly divided between Central Belt sandstone and mudstone and the Eastern Belt South Fork Mountain Schist. Limited portions of the eastern margin of the area are underlain by Klamath Mountains volcanics and metavolcanics.

Specific landslide data for this HPA were unavailable for review. However, it is assumed that landslide processes in this HPA are dominated by shallow landslide types and that deep-seated landslides also likely exist.

##### **4.4.4.4 Climate**

The large size of the Klamath basin and its geographic differences result in a wide range of climatic conditions. For the entire basin, the weather can be generalized as having dry summers with hot daytime temperatures and wet winters with low to moderate temperatures. Peak air temperatures occur during July with a monthly average

maximum of 65°F for the coast and 95°F inland. Precipitation is quite seasonal, with approximately 90% falling between October and March. Annual amounts vary from 20 inches to over 80 inches, depending on location. High intensity rainfall occurs during December-February and may cause flooding at times.

Snow occurs at higher elevations and some areas receive up to 80 inches annually. The highest instantaneous discharge ever recorded in the Klamath River was during the 1964 flood. At the town of Klamath the flow peaked at 650,000 cfs and caused considerable damage. Numerous Klamath River tributaries are still recovering from sediment inputs from this storm event.

In the South Fork Trinity sub-basin, the climate is generalized by hot, dry summers and cool, wet winters. The average annual precipitation for the South Fork basin is 30 to 60 inches, depending on altitude and distance from the Pacific Ocean. Most precipitation falls between November and March, with negligible amounts in localized areas between June and September. In higher elevations snow is a major component of the annual precipitation.

#### **4.4.4.5 Vegetation**

The Interior Klamath HPA spans the transition from coastal redwood/Douglas-fir forests to more mesic interior landscapes that are dominated by Douglas-fir/tanoak forests, with grasslands appearing on some drier ridge tops and south to west aspects.

On the east side of the Klamath River, redwood only occurs north of Cappell Creek and only on lower slopes along the river face. On the west side of the Klamath, redwood persists to the Redwood Creek divide in Roach Creek and throughout the area north and west of this tributary. Higher elevations at the eastern boundary of this HPA (4,000 - 4,500 feet) support montane conifer forests dominated by Douglas-fir and white fir. Red alder occurs in riparian zones along lower stream reaches throughout the HPA, and golden chinquapin can be found as a stand component on more xeric sites. Oregon white oak is common at the margins of grasslands, with California black oak also found on drier soils.

With the exception of the areas along the western margin of this HPA that are in Six Rivers National Forest, and some fragmented stands on the Hoopa Indian Reservation, most of the forest in this area is young growth originating from timber harvesting activities that occurred between the 1940s and the 1980s.

#### **4.4.4.6 Current Habitat Conditions**

##### **4.4.4.6.1 Water Temperature**

Water temperature monitoring on the Original Assessed Ownership in the Interior Klamath HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 24 summer temperature profiles were recorded at 13 sites in 10 Class I watercourses. An additional 6 summer temperature profiles were recorded at four headwater sites in 3 Class II watercourses.

Figure 4-19 displays the 7DMAVG (7 day maximum moving average) water temperatures for the each of the monitored sites in relation to the square root of the

watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for period (1994-2000) indicate that none of the Class I or Class II monitoring sites in this HPA exceeded the red or yellow light thresholds.

#### 4.4.4.6.2 Channel and Habitat Typing

Channel and habitat typing assessments were conducted in 11 streams in the Interior Klamath HPA by the Yurok Tribal Fisheries Program in 1996-7 (see Appendix C1 for details). The assessed streams (in descending order of mid-point watershed area), their mid-point watershed areas, and their gradients are as follows:

<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
Pecwan Creek	17,574 acres	3.5%
Roach Creek	10,808 acres	2.2%
East Fork Pecwan Creek	8,401 acres	4.1%
Tully Creek	7,264 acres	4.1%
Cappell Creek	5,312 acres	7.0%
Roach Creek Tributary	3,548 acres	2.6%
Mettah Creek	2,959 acres	2.8%
Morek Creek	2,562 acres	4.7%
Robbers Creek	2,106 acres	5.0%
South Fork Mettah Creek	1,558 acres	3.0%
Johnson Creek	1,307 acres	Not Available

The results of the assessments are summarized below and depicted in Figure 4-20 (A-F) (see Table C1-5 in Appendix C1 for data). The least squares regression displayed on the figure was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

The assessments indicate the following regarding the 11 assessed streams:

- In general, the percentage of canopy closure for the 11 assessed streams (74-94%) is similar to the range for all assessed streams on the Original Assessed Ownership (Figure 4-20 [A]).
- For the most part, percentage conifer canopy cover for the 11 streams is typical (8-41%) of the range for other assessed streams of similar watershed area, with the exception of Johnson Creek (Figure 4-20 [B]). Johnson Creek has 3% conifer canopy cover, a much lower percentage than that in other assessed streams. Cappell Creek has one of the highest percentages of conifer canopy cover (41%) of all assessed streams on the Original Assessed Ownership.
- The 11 assessed streams in this HPA had typical percentages of stream length in pools (21-60% by length) compared with other assessed streams of similar watershed area (Figure 4-20 [C]). The percentage of LWD as structural cover in pools for the 11 streams was lower (1.7-19.9%) than that for most assessed streams with similar watershed area (Figure 4-20 [D]).

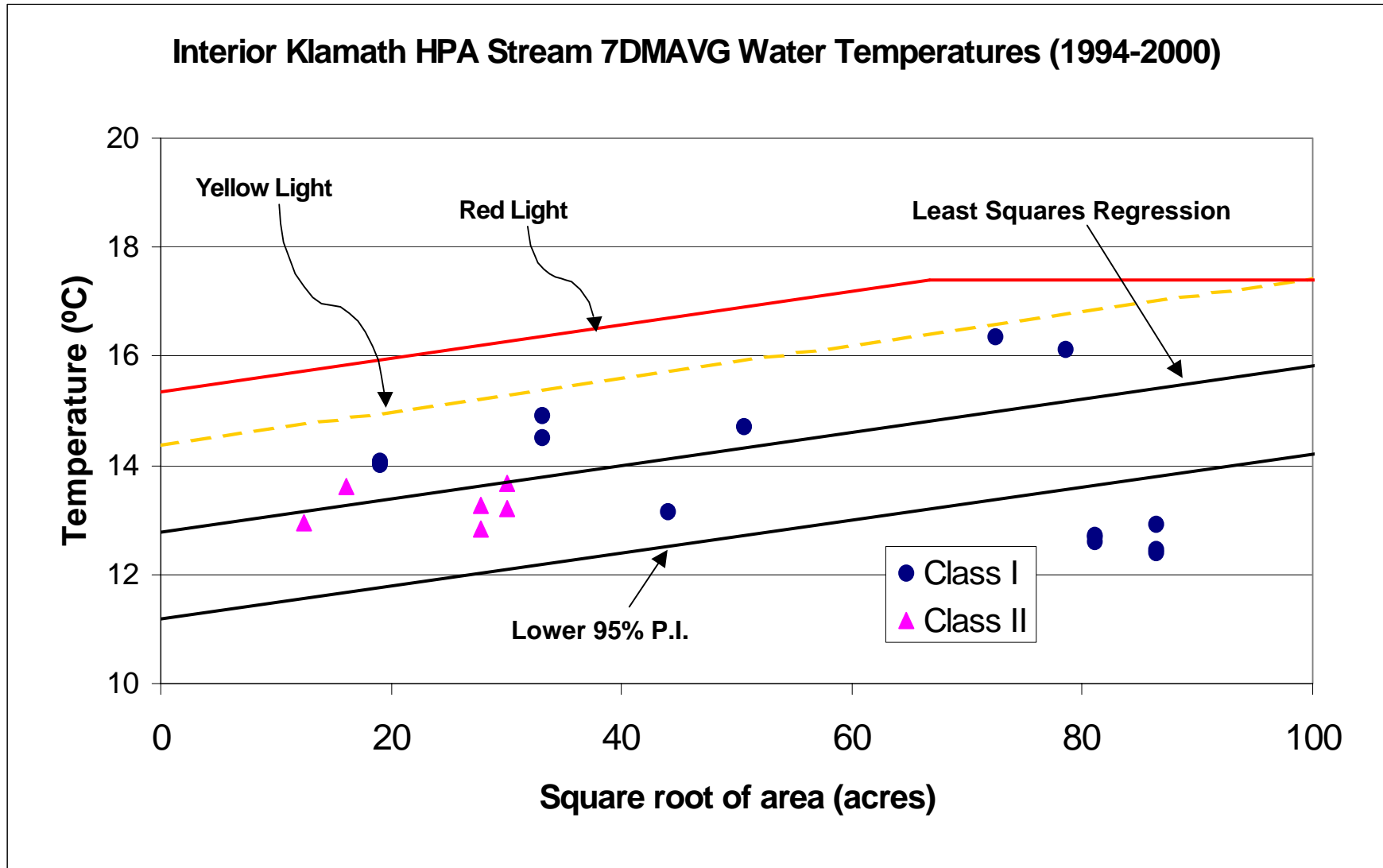
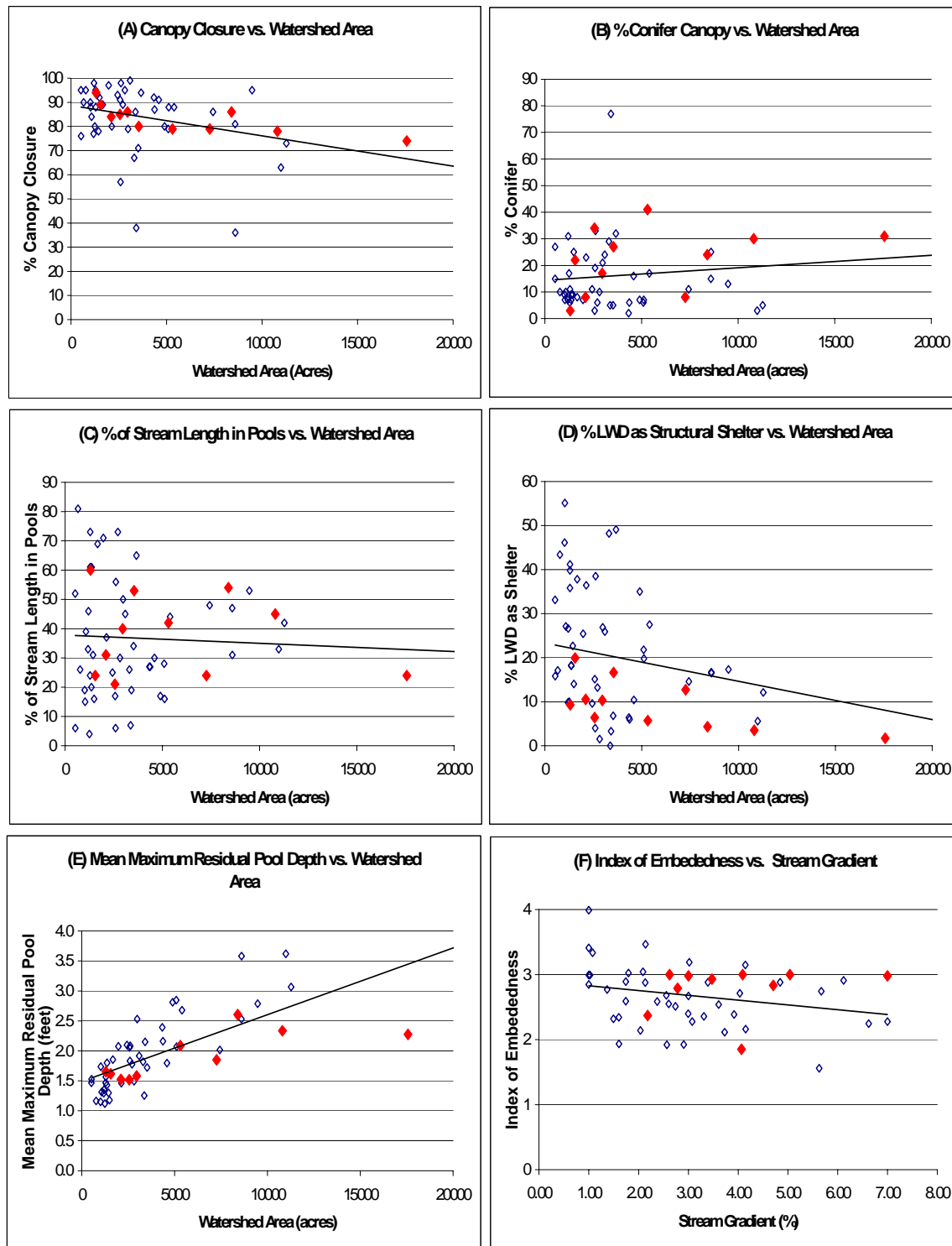


Figure 4-19. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Interior Klamath HPA monitored between 1994 and 2000.



**Figure 4-20.** Channel and habitat types in 11 streams assessed in the Interior Klamath HPA. (Solid diamonds are assessed streams in the Interior Klamath HPA; Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

- The average residual pool depth in the 11 assessed streams varies somewhat but for the most part appears similar to all assessed streams on the Original Assessed Ownership (Figure 4-20 [E]). Pecwan Creek has lower than expected average residual pool depths (2.3 feet) for its watershed area. With the exception of Tully and Roach creeks, the assessed streams in this HPA have substrate embeddedness indices which are somewhat greater than other assessed streams in the HPAs, regardless of stream gradient (Figure 4-20[F]).

In summary, these results suggest that the habitat within the 11 assessed streams of the Interior Klamath HPA are, in many instances, similar to other assessed streams of similar watershed area. There are, however, some habitat differences. The 11 streams in this HPA have on average a lower percentage of LWD as structural cover and many of the streams have greater embeddedness indices than other assessed streams.

#### **4.4.4.7 Salmonid Population Estimates**

Salmonid population surveys have not been conducted in the Initial Plan Area of this HPA.

#### **4.4.4.8 Covered Species Occurrence and Status**

Presence/absence of the Covered Species in Interior Klamath HPA is presented by drainage in Table 4-7, and the recorded distribution of the species is displayed in **Figure 4-21**.

##### **4.4.4.8.1 Chinook Salmon**

The Interior Klamath HPA includes the Southern Oregon/Northern California ESU and Upper Klamath-/Trinity Rivers Chinook ESUs.

The Southern Oregon/Northern California Chinook ESU was determined to not warrant listing as of September 1999 (64 FR 50394). In this ESU as a whole, juvenile production is thought to be increasing in the Winchuck River. The Smith River has the only known spring-run chinook population in coastal California. Chinook salmon are well distributed in smaller coastal streams, and recent increases in abundance have been noted in many of these (64 FR 50404-5).

The Upper Klamath-/Trinity Rivers Chinook ESU also was determined to not warrant listing. Specific information on chinook salmon escapements for streams within the Interior Klamath HPA is limited. Total chinook spawner escapement in the Klamath Basin is greatly reduced from historic estimates, and current escapement levels are supported by hatchery production (Voight and Gale 1998) (Busby et al. 1997).

**Table 4-7. Covered Species distribution in the Interior Klamath HPA.**

Watersheds and Sub-basins	Chinook	Coho	Steelhead	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Klamath River	2,3,4	1,2,3,4	2,3,4	2,3	3	3
Halagow Creek	A	A	2	U	P	3
Achelth Creek	A	A	U	U	3	P
Johnson Creek	2,3,4	1,3,4	2,3,4	3,4	P	3
Pecwan Creek	2	1	2	P	3	3
West Fork Pecwan Creek	A	A	2	P	P	3
Buzzard Creek	A	A	2	U	P	3
East Fork Pecwan Creek	A	A	2	P	3	3
Mettah Creek	2	1	2	P	3	3
Notchkoo Creek	A	A	A	A	P	P
Roach Creek	2	1,2,3,4	2,3,4	A	P	3
Morek Creek	A	A	2,3,4	A	3	3
Cappell Creek	2	A	U	A	P	P
Devil's Creek	A	A	U	A	P	P
Coon Creek	A	A	U	A	P	P
Tully Creek	P	1,2	2,3,4	A	3	3
Robbers Gulch	U	U	2	A	3	3
Pine Creek	P	1	2	A	U	U
Little Pine Creek	U	1	2	A	U	U
Bens Creek	U	A	U	A	U	U
Gist Creek	U	A	U	A	U	U
Cavanaugh Creek	U	A	U	A	P	3
Joe Marine Creek	U	A	U	A	U	U
<b>Codes</b>  U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records 4= Present based on Yurok Tribal Fisheries Program						

#### 4.4.4.8.2 Coho Salmon

The Interior Klamath HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened in May 1997 (62 FR 24588). Coho salmon populations are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of the coho abundance in the 1940s (Weitkamp et al. 1995). Specific information on coho populations for streams within the Interior Klamath HPA is limited. Recent sampling (1996) by the Yurok Tribal Fisheries Program found juvenile coho in 2 of 3 tributaries which historically have been reported to have coho; observed numbers were low (Voight and Gale 1998).

#### 4.4.4.8.3 Steelhead and Resident Rainbow Trout

The Interior Klamath HPA includes the Klamath Mountains Province Steelhead ESU, which was determined to not warrant listing as of April 2001 (66 FR 17845). Attempts to assess the population status of steelhead in this ESU are hampered by a lack of biological information. In general, there has been a replacement of naturally produced fish with hatchery fish, and downward trends in abundance in most populations (Busby et al. 1994).

Specific steelhead population abundance estimates for streams within the Interior Klamath HPA are generally non-existent. Yurok Tribal Fisheries Program sampling (1996) found juvenile steelhead are well-distributed in Interior Klamath tributaries (100% presence, n=4 tributaries sampled), but no estimates of abundance were made (Voight and Gale 1998). Steelhead populations in the Klamath River as a whole are significant (summer/fall-run size of 110,000, winter-run size 20,000) but thought to be largely hatchery-supported (Busby et al. 1994).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.4.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999). Short-term trends indicate increases in adult abundance in the lower Klamath River and its tributaries (Johnson et al. 1999).

Specific information on coastal cutthroat trout populations in the Interior Klamath HPA is almost non-existent. The Yurok Tribal Fisheries Program found coastal cutthroat in 1 of 4 tributaries in the HPA surveyed in 1996 (Gale et al. 1998). Gerstung (1997) suggests that coastal cutthroat typically do not occur above Mettah Creek. When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### 4.4.4.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in 11 streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Interior Klamath HPA, 7 of 11 (63.6%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 5 other streams in this HPA either through other types of amphibian surveys or incidental observations.

Given this moderate rate of occurrence and relatively small number of streams known to support the species, tailed frogs streams in the Interior Klamath HPA appear to be in only moderate condition.

#### **4.4.4.8.6 Southern Torrent Salamander**

Green Diamond conducted presence/absence surveys for southern torrent salamanders in 11 streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Interior Klamath HPA, 10 of 11 (90.9%) streams sampled as part of this presence/absence survey had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 56 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Given the high rate of occurrence and large number of streams known to support the species, southern torrent salamander streams in the Interior Klamath HPA appear to be in excellent condition.

#### **4.4.4.9 Assessment Summary**

Water temperatures are generally good throughout the Original Assessed Ownership in the Interior Klamath HPA, despite the warmer summer temperatures associated with this more interior region. Presumably this is due to the good canopy cover on streams in the Original Assessed Ownership this HPA. Like the Coastal Klamath HPA, the Interior Klamath is less subject to deep-seated instability than to shallow landslides and the relatively competent (consolidated) geologic parent material results in coarse stream substrates. Within the Original Assessed Ownership of this HPA, Class I watercourses are also generally deficient in LWD as cover in pools, but this is probably due to the abundance of steep confined channels that prevent LWD from being functional. In these streams, much of the pool formation is created by boulders and bedrock.

The Covered Species are relatively common throughout the Original Assessed Ownership in the Interior Klamath HPA; but in many of the Class I watercourses, only a small portion near the mouth is open to anadromy. Natural barriers associated with steep gradient reaches preclude coho and chinook salmon from the majority of many streams. Resident trout (rainbow and/or cutthroat) are the only salmonids that occur throughout much of the Class I watercourses. It is not likely that water temperature limits populations of any Covered Species in streams on the Original Assessed Ownership in this HPA. The steep gradients associated with many streams in this HPA limit the quantity and quality of the salmonid habitat, so that past management activities probably have had comparatively less impact on current habitat conditions relative to other HPAs. However, the relative lack of tailed frog populations in the Original Assessed Ownership in this HPA support the field observation that past management activities have substantially influenced many of the lower gradient headwater streams. These areas appear to have been impacted primarily by excessive sediment inputs. The abundance of southern torrent salamanders in the Original Assessed Ownership seems inconsistent with the relative lack of tailed frogs. However, Green Diamond's research on these two Covered Species indicates that torrent salamanders are primarily sensitive to direct impacts (harvesting activities that directly destroy a headwater seep or spring), whereas tailed frogs are more sensitive to indirect impacts from sediment inputs such as debris torrents initiated from legacy roads (Diller and Wallace 1999).

Based on these observations, the top conservation priority for the Plan Area in this HPA should be to address potential sediment inputs from legacy road sites.

#### **4.4.5 Redwood Creek HPA**

##### **4.4.5.1 HPA Type, Size, and Group**

The Redwood Creek HPA is a hydrographic unit as defined in this Plan and includes 188,335 acres. It is part of the Korbel HPA Group.

##### **4.4.5.2 Eligible Plan Area**

The Eligible Plan Area in the Redwood Creek HPA includes approximately 100,731 acres: 33,038 acres of Initial Plan Area and 67,693 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). All of the initial Plan Area in this HPA is part of the Original Assessed Ownership.

##### **4.4.5.3 Geology**

The Redwood Creek HPA is within the Coast Ranges Geologic Province (see **Figure 4-1**). Because substantial geologic mapping and research has been done in the Redwood Creek area, the geology, landform development, and mass wasting characteristics of this HPA are probably the best understood of all of the HPAs.

Over one-half of the HPA is composed of Redwood Creek Schist. Other major rock units in this HPA include the Incoherent Unit of Coyote Creek, the Coherent Unit of Lacks Creek, and the Sandstone and Melange of Snow Camp Mountain. Coastal plain and marine terrace sediments are located in the northern coastal portion of the HPA. These sediments are mainly composed of unconsolidated to slightly consolidated sands, silts, and gravels and may be as much as 300 feet thick.

Most of this HPA is underlain by the Redwood Creek Schist. Much smaller sections of the ownership, located to the east and southeast, are underlain by the Incoherent Unit of Coyote Creek and the Coherent Unit of Lacks Creek. A small section of the Plan Area, located at the southern tip of the HPA, is underlain by the Sandstone and Melange of Snow Camp Mountain.

The major bedrock units in the HPA are set apart from one another by a series of major northwest trending faults. The most notable of the faults found in this unit include the Grogan fault, which defines the channel of Redwood Creek and separates the Redwood Creek Schist from the Incoherent Unit of Coyote Creek. Other notable faults include Indian Field Ridge and Snow Camp Creek. The Indian Field Ridge fault separates the Incoherent Unit of Coyote Creek from the Coherent Unit of Lacks Creek. The Snow Camp Creek fault is located at the southern tip of the HPA and separates Redwood Creek Schist from the Sandstone and Melange of Snow Camp Mountain.

Many hillslopes in the Redwood Creek basin are unstable and highly susceptible to mass-movement failure because of the steepness of the terrain and the low shear strength of much of the underlying saprolite and residual soil. This is especially true in the Incoherent Unit of Coyote Creek, although shallow landslides also exist in the HPA. According to Colman (1973), at least 36% of the basin shows landforms that are the result of active mass movements or that are suggestive of former mass-movement failures. Complex associations of rotational slumping, translation, and earthflows are the most visually obvious forms of mass movement in the Redwood Creek basin. Some

have clearly defined margins, but many gradually merge with less active areas of soil creep. On many earthflows, grass, grass-bracken-fern, and grass-oak prairie vegetation dominate in marked contrast to the mature coniferous forest or cutover land on more stable slopes.

Several lithologies occur within the Redwood Creek Schist, and the geomorphic expression of the different schist units is variable. Slopes underlain by the Redwood Creek Schist have gently convex profiles, and side-slope gradients commonly range from 20% to 40%. Both the Redwood Creek Schist and the South Fork Mountain Schist exhibit knobby topography in areas where greenstone units of tectonic blocks are included in the schist. Shallow, incised streams are a typical drainage feature of schist slopes (Cashman et al. 1995). In addition, some evidence of deep-seated, slow moving, landslide deposits have been identified in road cut exposures in the schist units (Cashman et al. 1995).

The sandstone and mudstone of the Coherent Unit of Lacks Creek have a distinct geomorphic expression. Sharp ridges, steep slopes and narrow V-shaped tributary canyons are characteristic of the landscape developed on these relatively resistant rocks. Slopes have straight to gently concave profiles, and slope gradients commonly range from 30% to 50%. In the Coherent Unit, streamside debris slides and debris avalanches are common in the inner gorges of tributaries (Cashman et al. 1995). In contrast to the steep terrain of the Coherent Unit, the bedrock of the Incoherent Unit of Coyote Creek forms a subdued rolling landscape having less deeply incised drainage networks and few high points and knobs formed by resistant rock types. Earthflows are preferentially developed in this unit, as are streamside debris slides along inner gorges.

Rocks in the Grogan Fault Zone are intermediate in texture and degree of metamorphism between the Redwood Creek Schist and the sandstone and mudstone units. The geomorphic expression of this area is similar to that of the Incoherent Unit of Coyote Creek, and streamside debris slides are concentrated along linear zones of sheared rocks parallel to the Grogan fault (Harden et al. 1981).

The landscape developed on the sandstone and melange unit of Snow Camp Mountain is generally more hummocky than other hillslopes in the HPA.. However, parts of the Snow Camp Mountain unit are underlain by massive sandstone and display steep slopes, prominent ridges, and V-shaped valleys, in contrast to the more rolling hummocky hillslopes underlain by melange. Tectonic blocks of greenstone and chert form prominent knobs and summits (Cashman et al. 1995). As in the Coherent Unit of Lacks Creek, streamside debris slides and debris avalanches are common in the inner gorges of tributaries and in steeper areas underlain by massive sandstone.

#### **4.4.5.4    *Climate***

Precipitation in the Redwood Creek basin is highly seasonal, with 90% occurring between October and April. The annual average for the basin is almost 80 inches, with over 90 inches occurring in localized areas. December is usually the wettest month with about 17% of the annual total falling.

#### **4.4.5.5 Vegetation**

The Redwood Creek HPA supports cover types that range from Sitka spruce/Douglas-fir forest at the coast to Douglas-fir/white fir forest at the origin of Redwood Creek, 46 miles south-southeast of its mouth.

In the Redwood Creek watershed, the redwood/Douglas-fir type includes grand fir, western red cedar, and western hemlock on lower slopes near the coast and in riparian zones. Red alder is the most common hardwood in riparian zones, and tanoak is the most common mid to upper slope hardwood. Aspect strongly affects the distribution of redwood within the watershed. Redwood persists roughly half way up the west side of the drainage, but only one-third of the way up the east side. The drier regime created by the west facing slope also leads, along with soil type differences, to the appearance of natural grasslands on the east side of the drainage approximately 10 miles from the mouth of redwood creek, while they do not appear on the west side until south of Highway 299, approximately two-thirds of the way up the drainage. These grasslands and associated true oak woodlands become more prominent in the upper portion of the watershed, leading to a history of agricultural use, principally livestock grazing, since white settlers arrived. The middle to upper reaches of Redwood Creek transition rapidly to Douglas-fir/tan-oak forest at the limits of the redwood type, and white fir becomes prevalent near the watershed's 5300-foot crest.

Agricultural development and the small town of Orick on the alluvial plain between Redwood Creek's estuary and the mouth of Prairie Creek constitute the only significant conversion of native forest to other uses within the drainage. Except for that area, roughly the lower third of the drainage is in Redwood National and Prairie Creek State parks. The parks support 25,000 acres of old growth uncut coniferous forest, principally redwood and redwood/Douglas-fir type, and another 1800 acres where logging has occurred but over 50% of the original stand remains. The remainder of the forested area within the watershed has been harvested since the 1930s, with very few sites that support any significant remnants of the original forest.

#### **4.4.5.6 Current Habitat Conditions**

##### **4.4.5.6.1 Water Temperature**

Water temperature monitoring on the Original Assessed Ownership in the Redwood Creek HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 15 summer temperature profiles were recorded at 7 sites within 6 Class I watercourses. An additional 22 summer temperature profiles have been recorded at 9 headwater sites within 7 Class II watercourses within the HPA. Figure 4-22 displays the 7DMAVG water temperatures for each of the monitored sites in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for the period (1994-2000) indicate that one Class I site (Coyote Creek) exceeded the yellow light threshold in 1999 and the red light threshold in 2000; one Class II site (Lake Prairie Creek) exceeded the yellow light threshold in 1999 and 2000.

#### **4.4.5.6.2 Estuarine Conditions**

After the flood of 1964, which inundated the town of Orick with five feet of water, the U.S. Army Corps of Engineers constructed a levee from Prairie Creek to the ocean. During low summer flows, the north and south sloughs of the estuary become isolated and anoxic. The lower three miles of Redwood Creek also are devoid of riparian vegetation and large woody debris because the Corps of Engineers requires that the levee's channel be clear of debris that may lessen its transport capacity.

#### **4.4.5.7 Salmonid Population Estimates**

Salmonid population surveys have not been conducted in the Initial Plan Area of this HPA.

#### **4.4.5.8 Covered Species Occurrence and Status**

Presence/absence of the Covered Species in the Redwood Creek HPA is presented by drainage in Table 4-8, and the recorded distribution of the species is displayed in **Figure 4-23**.

##### **4.4.5.8.1 Chinook Salmon**

The Redwood Creek HPA is the northernmost boundary of the California Coastal Chinook ESU, which was listed as threatened under the ESA in September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance were cited in the decision to list this ESU as threatened (64 FR 50405).

Specific information on chinook in the Redwood Creek HPA is limited. Spawner escapement for fall chinook in Redwood Creek was estimated to be approximately 5,000 in the mid-1960s (Myers et al. 1998). Nehlsen et al. (1991) characterized fall-run chinook in Redwood Creek as at 'moderate risk of extinction', and a reanalysis by Higgins et al. (1992) resulted in an upgrade in status to 'stocks of special concern'.

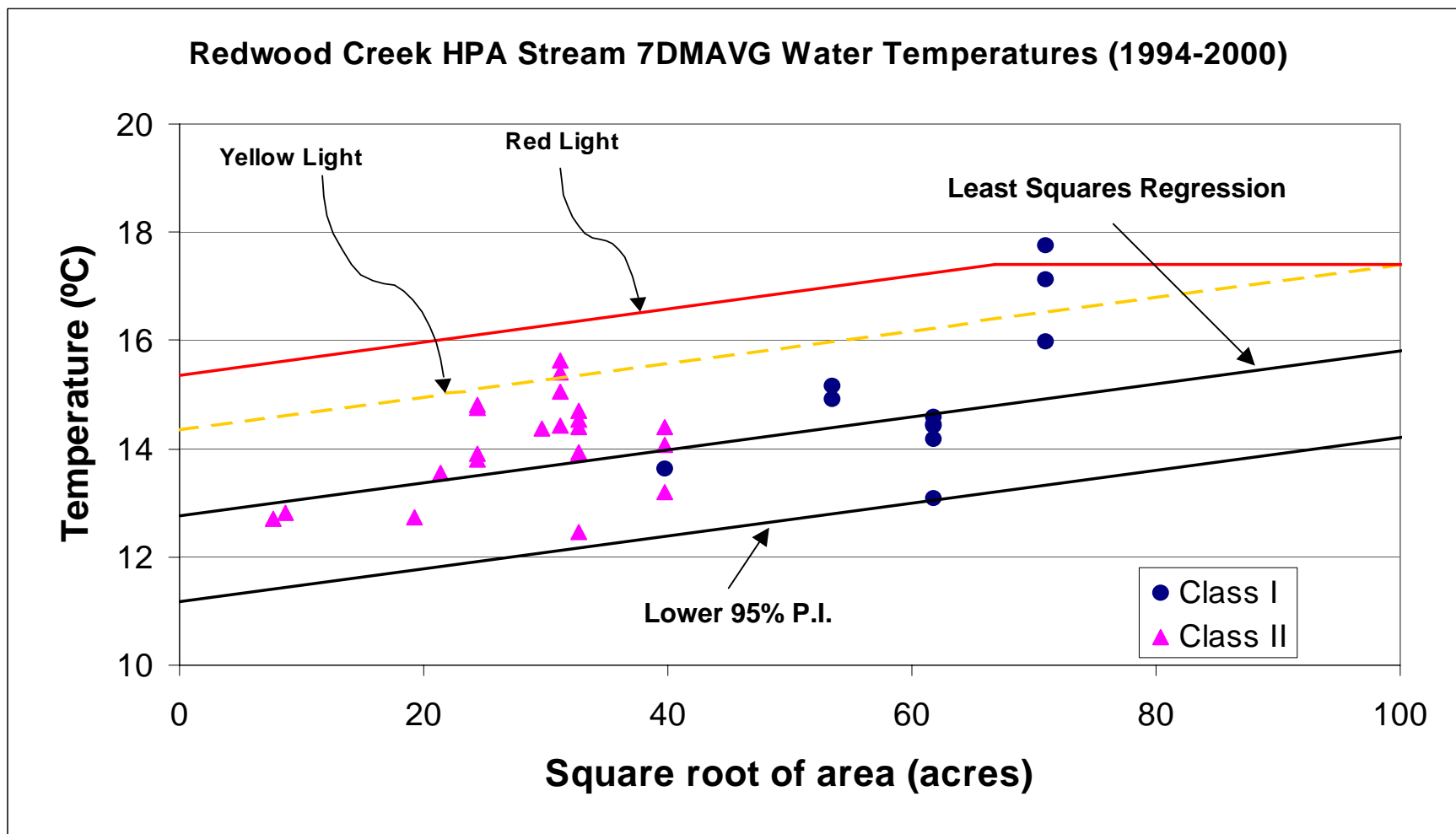


Figure 4-23. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Redwood Creek HPA monitored between 1994 and 2000.

**Table 4-8. Covered Species distribution in the Redwood Creek HPA.**

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Cutthroat	Tailed Frog	Torrent Salamander
Redwood Creek	3	1	3	3	3	3
Coyote Creek	P	1,2,4	2,3,4	3	3	3
Panther Creek	P	1,2	2,3,4	3	3	3
Garrett Creek	A	A	4	U	P	P
Dolly Varden Creek*	A	4	4	U	3	3
Beaver Creek	A	A	2,4	U	P	3
Toss-Up Creek	A	U	4	U	P	3
Minor Creek	2	2	2,4	U	3	P
Lupton Creek	A	A	2,4	U	3	3
Noisy Creek	A	A	3,4	U	3	3
Cool Spring Creek	A	A	U	U	P	P
Miñon Creek	U	U	3,4	U	P	P
Lake Prairie Creek	A	A	2,4	U	3	3
Panther Creek	A	A	3,4	U	P	P
Bradford Creek	A	A	4	U	P	P
Pardee Creek	A	A	3,4	U	3	3
Twin Lakes Creek	A	A	3,4	U	P	P
Smokehouse Creek	A	A	4	U	P	P
Snow Camp Creek	A	A	4	U	P	P
<b>Codes</b> U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT= resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur 1= Present based on NMFS data files as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records 4= Present based on Brown 1988; Anderson 1988; RNSP 1994; and RNSP 1995-1996.						

#### 4.4.5.8.2 Coho Salmon

The Redwood Creek HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA in May 1997 (62 FR 24588). Coho salmon populations are depressed throughout this ESU. Current coho salmon abundance in the California portion of this ESU is thought to be less than 6% of their abundance in the 1940s (Weitkamp et al. 1995).

#### 4.4.5.8.3 Steelhead and Resident Rainbow Trout

The Redwood Creek HPA is the northern boundary of the Northern California Steelhead DPS, which was listed as threatened in June 2001 (65 FR 36074). Steelhead abundance data is very limited for this ESU, but available data indicates that winter-run steelhead populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then. Nehlsen et al. (1991) identified summer steelhead in Redwood Creek as 'at risk of extinction'. NMFS found that for the seven populations of steelhead within this ESU only the small summer

steelhead population within the Mad River, which has had large supplemental production from hatchery sources and Prairie Creek winter steelhead have shown recent trends of increasing abundance (65 FR 36082). Prairie Creek is a tributary to Redwood Creek and as such is within the Redwood Creek HPA

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.5.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Redwood Creek historically supported a large population of anadromous coastal cutthroat trout. The current population is thought to be very depressed compared to historical estimates but relatively stable (Gerstung 1997). Severe alteration of the estuary environment and habitat degradation from logging in the 50s and 60s, compounded by the 1964 flood, are believed to be largely responsible for the depressed state of the population (Gerstung 1997). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### 4.4.5.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in six streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Redwood Creek HPA, 6 of 6 (100%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 11 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Although a relatively small portion (18%) of the HPA is in Green Diamond's ownership, the high rate of occurrence and significant number of other streams known to support the species suggest that tailed frogs streams in the Redwood HPA are in good condition.

#### 4.4.5.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in six streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams that supported populations of southern torrent salamanders (Diller and Wallace 1996). In the Redwood Creek HPA, 5 of 6 (83.3%) sampled streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 61 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Although a relatively small portion (18%) of the HPA is in Green Diamond's ownership, the high rate of occurrence and large number of other streams known to support the

species suggest that torrent salamander streams in the Redwood Creek HPA are in good condition.

#### **4.4.5.9 Assessment Summary**

Water temperatures are generally good throughout the Original Assessed Ownership in the Redwood Creek HPA despite the warmer summer temperatures associated with this more interior region. Presumably this is due to the good canopy cover on the streams in the Original Assessed Ownership in this HPA. There were two exceptions to this generalization. One was the lower mainstem of Coyote Creek, which has high canopy closure but much of its drainage area in prairies in Redwood National Park. Hand held temperature recordings from these prairie tributaries indicate that they are likely the source of the warm water in the mainstem of Coyote Creek. The other exception is a Class II watercourse (Lake Prairie Creek), which was impacted by a debris torrent in the winter of 1996/97 that removed all the streamside vegetation.

The soft and fractured nature of the sheared bedrock associated with the Grogan Fault, which controls the trace of Redwood Creek, as well as the inherently weak nature of some of the geologic parent material (Redwood Creek Schist) in the basin contribute to the relatively high amounts of fines in streams. There are no data available for a quantitative assessment of canopy closure, LWD, or other aspects of aquatic habitat in streams on the Original Assessed Ownership in the Redwood Creek HPA. However, most streams (not including the mainstem of Redwood Creek) are high gradient with limited access to anadromous salmonids. These streams are generally boulder dominated. LWD, whether or not it is in short supply, is probably not an important habitat element. In these streams, much of the pool formation is created by boulders and bedrock.

The salmonid Covered Species, especially coho and chinook salmon, are relatively uncommon in streams on the Original Assessed Ownership in this HPA. Many of the streams are sufficient in size and have good water quality to support populations of fish, but anadromous access is limited due to stream gradient. The primary anadromous habitat in this HPA is in the mainstem of Redwood Creek and some of the lower tributaries of the watershed, which support good populations of both coho and chinook salmon. Steelhead and resident populations of rainbow and coastal cutthroat trout persist throughout the watershed, although likely at reduced densities. Water temperature may limit some populations of the Covered Species in isolated locations of the Original Assessed Ownership within the HPA. The lower portion of Coyote Creek may have water temperatures that impair salmonid populations, but the maintenance of prairies in Redwood National Park would preclude corrective action. The high water temperatures following a debris flow in Lake Prairie Creek negatively impacted larval tailed frogs, but the regrowth of riparian vegetation allowed for substantial recovery after five years. Although similar debris flows have the potential to occur given the steep terrain in many of the headwater streams in this HPA, the rate of their occurrence relative to the rate of recovery would not likely result in widespread impacts on the amphibian Covered Species in the Original Assessed Ownership throughout this HPA. The high occurrence of tailed frogs on the Original Assessed Ownership in this HPA supports this conclusion.

The steep gradients associated with most of the streams on the Original Assessed Ownership in this HPA limit the quantity and quality of the salmonid habitat.

Consequently, conservation measures implemented under this Plan will likely have little direct impact on the future occurrence of salmonids in those streams. However, the streams have the potential to deliver large amounts of coarse and fine sediments to the mainstem of Redwood Creek, which supports all of the salmonid Covered Species. Therefore, the top conservation priority for the Plan Area in this HPA should be to address potential sediment inputs from legacy road sites or hillslopes that would trigger debris flows or result in other substantial sediment transport to the mainstem of Redwood Creek.

#### **4.4.6 Coastal Lagoons HPA**

##### **4.4.6.1 HPA Type, Size, and Group**

The Coastal Lagoons HPA is a hydrographic area as defined in this Plan and includes 53,592 acres. It is part of the Korbel HPA Group.

##### **4.4.6.2 Eligible Plan Area**

The Eligible Plan Area in the Coastal Lagoons HPA includes approximately 44,649 acres: 39,981 acres of Initial Plan Area and 4,678 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

##### **4.4.6.3 Geology**

The Coastal Lagoons HPA is within the Coast Ranges Province (see **Figure 4-1**). From east to west, the bedrock in this HPA includes the Redwood Creek Schist, the Sandstone and Melange of Snow Camp Mountain, Undifferentiated Central Belt Franciscan Sandstone, the Patrick's Point meta-graywacke unit, and younger marine and non-marine terrace deposits near the coastline. These geologic units are generally structurally bounded by northwest trending thrust faults and high angle faults. Broad northwest trending anticlines and synclines are also mapped within the hydrographic region.

The topography of the HPA is moderately-steep, except in the younger terrace deposits and in the area of the lagoons near the coastline. A preliminary inventory of landslides on the Original Assessed Ownership indicate that both shallow and deep-seated landslides exist in this HPA.

##### **4.4.6.4 Climate**

The coastal weather pattern in this HPA is typical for the lagoons. Summers are mild in temperature with a marine fog layer commonly occurring. Winters are cooler with an average annual rainfall of 40 to 60 inches, heavier amounts falling in the more inland areas. Most of the precipitation falls between October and April.

#### **4.4.6.5    *Vegetation***

The Coastal Lagoons HPA encompasses the coastal streams between Redwood Creek and Little River, and its inland extent is defined by the divide into those drainages. The HPA extends only 10 miles inland and crests at 2,800 feet elevation. It is entirely within the zone of summer fog intrusion, and all vegetative types therefore reflect a strong coastal influence.

Aside from coastal scrub and wetland vegetation around the lagoons, and residential development along U.S. Highway 101 (including the town of Trinidad), the entire HPA is forested. Sitka spruce and Douglas-fir/spruce forests along the coast rapidly give way to redwood and redwood/Douglas-fir forests that persist to the eastern boundaries of the HPA. Minor amounts of grand fir, western red cedar, and western hemlock occur on lower slopes near the coast and in riparian zones. Red alder dominates many riparian zones, and tanoak is the most common mid to upper slope hardwood.

#### **4.4.6.6    *Current Habitat Conditions***

##### **4.4.6.6.1    Water Temperature**

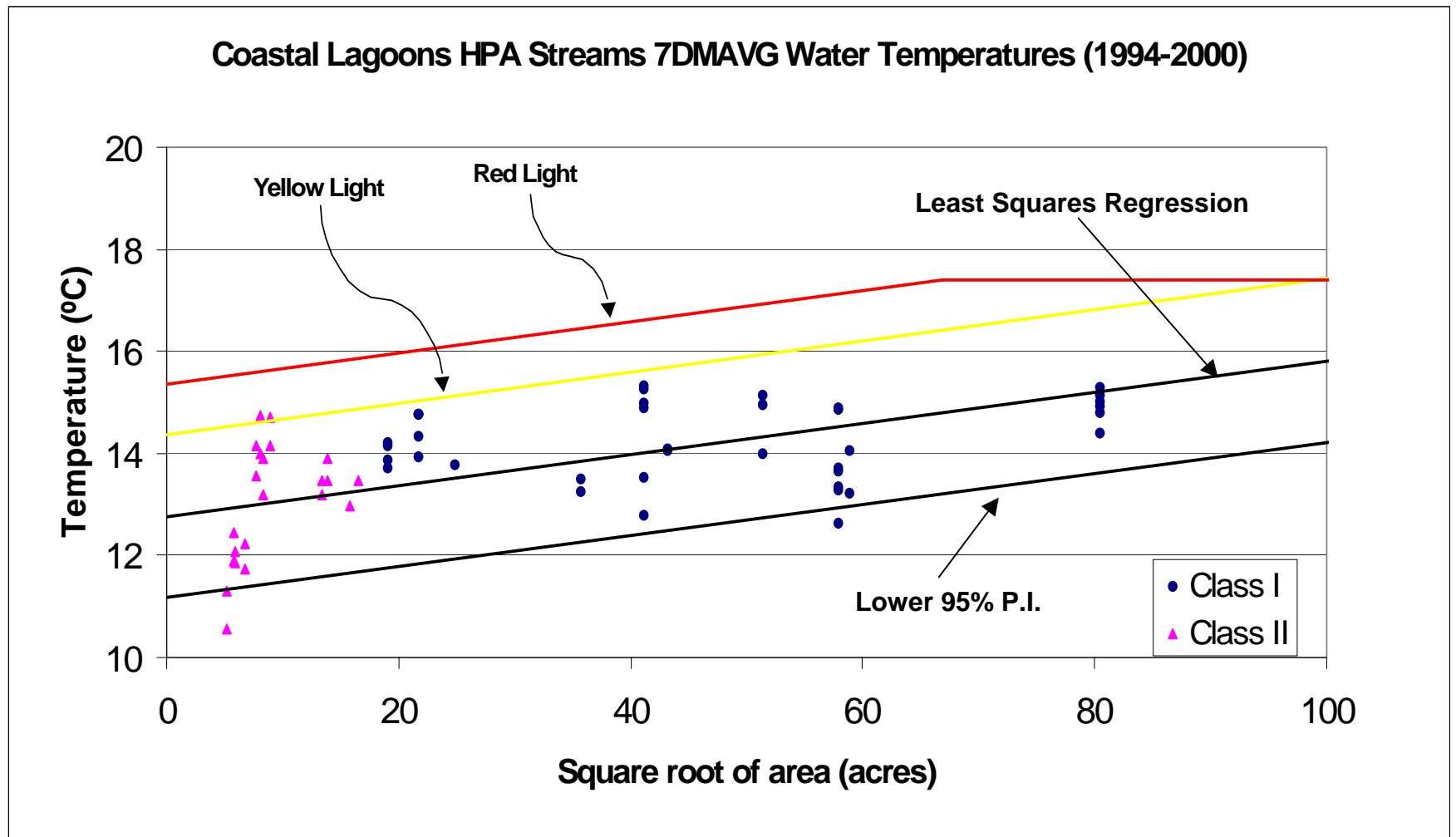
Water temperature monitoring in streams in the Original Assessed Ownership in the Coastal Lagoons HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 43 summer temperature profiles were recorded at 13 sites in 9 Class I watercourses. An additional 22 summer temperature profiles were recorded at 12 sites within 11 Class II watercourses. Figure 4-24 displays the 7DMAVG water temperatures for each of the monitored sites in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for the period (1994-2000) indicate that none of the Class I sites exceeded the red or yellow light threshold; two Class II sites (M1TD and M1TD2) exceeded the yellow light threshold during 2000.

##### **4.4.6.6.2    Long Term Channel Monitoring**

Channel monitoring is ongoing in two locations within the Coastal Lagoons HPA: Maple Creek and Beach Creek. Monitoring began on both reaches in 1998 (see Appendix C3 for details). Data has not been analyzed at the present time and no conclusions can be drawn at this point in the monitoring.

##### **4.4.6.6.3    Estuarine Conditions**

Stone Lagoon is approximately 500 acres in size, and it is where salmonids from McDonald Creek generally rear to maturity. Because the lagoon only opens to the ocean occasionally, salmonids have limited opportunities to pass between the two water bodies. However, the brackish lagoon is highly productive and supports a diverse aquatic ecosystem.



**Figure 4-24.** 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Coastal Lagoons HPA monitored between 1994 and 2000.

#### **4.4.6.7 Salmonid Population Estimates**

No salmonid population estimates have been made for streams within the Coastal Lagoons HPA. However spawning surveys have been conducted recently on some streams within this HPA (see Appendix C9).

##### **4.4.6.7.1 Adult Spawner Surveys**

Spawning surveys have been conducted on three streams within the Coastal Lagoons HPA during the period of 1998 through 2000. The streams and years surveyed are:

- Maple Creek: 1998-1999 and 1999-2000
- North Fork Maple Creek: 1998-1999 and 1999-2000
- Pitcher Creek: 1998-1999 and 1999-2000

The streams of the Coastal Lagoon HPA are subject to irregular entry by returning salmonids. These systems are regulated by high flow events that allow for the breaching of the sand spit, which would otherwise block the entry of salmonids into their natal streams. Based on spawning survey results since 1998, it is unclear whether adequate adult escapement is received in these streams due to the timing of when the lagoon breaches. Indications are that the timing of when the lagoon breaches plays an important role in determining if, when or what species enter the Maple Creek system. The absence of 0+ coho during the summer of 1999 indicates that Big Lagoon did not breach during the 1998/1999 coho run, but the presence of 1+ coho indicates that adults were able to enter during the 1997/1998 spawning season. During the formal spawning surveys only redds of unknown species have been found late in the survey season. It is likely these redds were created by anadromous or "lagoon run" cutthroat or by steelhead that were able to enter the lagoon during high winter flow. All four covered salmonid species have been observed in the Coastal Lagoon HPA; however coastal cutthroat trout is the only species that have been seen in the adult form.

#### **4.4.6.8 Covered Species Occurrence and Status**

Presence/absence of the Covered Species in the Coastal Lagoons HPA is presented by drainage in Table 4-9, and the recorded distribution of the species is displayed in **Figure 4-25**.

##### **4.4.6.8.1 Chinook Salmon**

The Coastal Lagoons HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA in September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU are cited in the decision to list this ESU as threatened (64 FR 50405). Specific information on chinook in the Coastal Lagoons HPA is limited. Chinook populations, if present, are probably small and potentially absent in many years. Big and Stone Lagoons are only open to the ocean for short time periods in winter and early spring, limiting the ability of anadromous fishes particularly chinook salmon to migrate between the ocean and the lagoons.

**Table 4-9. Covered Species distribution in the Coastal Lagoons HPA.**

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Stone Lagoon						
McDonald Creek	U	1	3	3	3	3
North Fork McDonald	U	U	3	3	P	3
Big Lagoon	3	1,3	3	3	U	U
Maple Creek	3	1,3	3	3	3	3
Diamond	A	A	U	U	U	U
Pitcher Creek	3	3	3	3	3	3
NF Maple Creek	3	3	3	3	3	3
M-Line Creek	A	A	3	3	P	3
Beach Creek	A	A	3	3	P	3
Clear Creek	A	A	3	3	P	3
Gray Cr. (into mill pond)	A	A	U	3	U	U
Mill Cr.	A	A	U	3	U	U
Luffenholtz	A	A	3	3	U	3
North Fork Luffenholtz	A	A	3	3	U	U
<b>Codes</b>  U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT= resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records						

#### 4.4.6.8.2 Coho Salmon

The Coastal Lagoons HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA as of May 1997 (62 FR 24588). Coho populations are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

As many as approximately 1,200 coho salmon were estimated to occur in Maple Creek, a tributary to Big Lagoon, as late as the 1960s (USFWS 1967). Currently, specific information on coho salmon in the Coastal Lagoons HPA is limited. Coho populations are probably small, and possibly absent in some years. Big and Stone Lagoons are only open to the ocean for relatively short time periods (days to weeks) in winter and early spring, limiting the ability of anadromous fishes to migrate between the ocean and the lagoons.

#### 4.4.6.8.3 Steelhead and Resident Rainbow Trout

The Coastal Lagoons HPA includes the Northern California Steelhead DPS, which was listed as threatened on June 4, 2000 (65 FR 36074). Steelhead abundance data are very limited for this DPS, but available data indicate that winter-run steelhead populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby et al. 1996).

Specific information on steelhead populations in the Coastal Lagoons HPA is limited. As many as 3,000 steelhead may have occurred in Maple Creek as late as the 1960s (USFWS 1967). Recent spawning surveys conducted by Green Diamond during 1998 and 1999 recorded only a small number of redds, indicating limited spawning by salmonids in Maple, North Fork Maple, and Pitcher Creeks. Big and Stone Lagoons are only open to the ocean for relatively short time periods (days to weeks) in winter and early spring. This is likely limiting the ability of anadromous fishes to migrate between the ocean and the lagoons. The lagoons do, however, provide rearing habitat for juveniles and holding and foraging habitat for adult steelhead trout.

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.6.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Big Lagoon is believed to support a "fair" population of coastal cutthroat trout (Gerstung 1997). Green Diamond observed high numbers of large coastal cutthroat in lower Maple Creek in 1999. Stone Lagoon had low numbers of cutthroat prior to heavy stocking of yearling fish in 1990-1994. Spawning escapement in McDonald Creek increased dramatically in the years following the stocking, but conditions in McDonald Creek are degraded and limit natural production (Gerstung 1997). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined not to warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### 4.4.6.8.5 Tailed Frog

Green Diamond's ownership in the Coastal Lagoon HPA was acquired in 1998 after the presence/absence surveys for tailed frogs were completed. Sampling was not conducted in the HPA as part of the study of 72 streams. However, populations of tailed frogs have been confirmed in 22 streams in the HPA either through other types of amphibian surveys by the prior landowner or incidental observations since the acquisition of the property by Green Diamond.

Given the significant number of streams known to support the species, tailed frogs streams in the Coastal Lagoon HPA are likely to be in good condition.

#### 4.4.6.8.6 Southern Torrent Salamander

Green Diamond's ownership in the Coastal Lagoon HPA was acquired in 1998 after the presence/absence surveys for southern torrent salamanders were completed. Sampling was not conducted in the HPA as part of the study of 71 streams. However, populations of torrent salamanders have been confirmed in 47 streams throughout the HPA either through other types of amphibian surveys by the prior landowner or incidental observations since the acquisition of the property by Green Diamond.

Given the significant number of streams known to support the species, torrent salamander streams in the Coastal Lagoon HPA are likely to be in good condition.

#### **4.4.6.9 Assessment Summary**

Due to the coastal influence and high canopy closure on most streams, water temperatures are generally good in streams throughout the Original Assessed Ownership in the Coastal Lagoons HPA. The geologic parent material is relatively competent (consolidated) in some areas, but less so in others. Stream substrates range from relatively coarse in many streams to being predominately composed of fines in others.

The Covered Species are relatively common throughout the Original Assessed Ownership in this HPA, except chinook and coho salmon. Since most of these streams drain into a lagoon, the infrequent and stochastic breaching of the lagoons restricts the presence of salmon. Steelhead and coastal cutthroat are probably less impacted by the breaching of the lagoons, because the adult fish are able to reside in the lagoons. Based on qualitative assessments, coastal cutthroat trout appear to be particularly abundant in this HPA, which is likely due to the reduced competition with anadromous salmonids. It is not likely that water temperature in streams on the Original Assessed Ownership limits populations of any Covered Species, and temperatures may be optimum for some Covered Species in most streams. There are no data to quantitatively assess canopy closure, LWD, or other aspects of aquatic habitat in the streams. However, spawning habitat for the salmonid Covered Species in most streams on the Original Assessed Ownership is probably good to adequate and is probably not limiting except for isolated reaches of some streams. Qualitative assessments indicate that LWD is probably relatively more abundant in streams on the Original Assessed Ownership in this HPA than in other HPAs. Therefore, the amount and/or quality of summer and winter rearing habitat is probably good for the populations of salmonids that utilize the streams in this HPA. The amphibian Covered Species are relatively common in the Original Assessed Ownership throughout this HPA. However, there are no data to determine the proportion of streams on the Original Assessed Ownership in the HPA supporting these species. The relative high number of sites with the amphibian Covered Species is consistent with the presence of cold water temperatures and competent geology and coarse stream substrates. However, based on anecdotal observations and recently initiated headwaters monitoring sites, many streams appear to have relatively high inputs of fines sediments from roads.

Given the limitations to anadromy caused by the lagoons, the highest conservation priority for the Plan Area in this HPA probably should be to address road-related sediment inputs that may impact the resident rainbow and coastal cutthroat trout and the amphibian Covered Species.

#### **4.4.7 Little River HPA**

##### **4.4.7.1 HPA Type, Size, and Group**

The Little River HPA is a hydrographic unit as defined in this Plan and is part of the Korbel HPA Group. It includes approximately 29,703 acres.

#### **4.4.7.2 Eligible Plan Area**

The Eligible Plan Area in the Little River HPA includes approximately 27,949 acres: 26,041 acres of Initial Plan Area and 1,908 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

#### **4.4.7.3 Geology**

The Little River HPA falls within the Coast Ranges Province (see **Figure 4-1**). From east to west, the bedrock of the HPA is composed of Redwood Creek Schist (along the eastern margin), Sandstone and Melange of the Snow Camp Mountain, and Undifferentiated Central Belt Franciscan Bedrock. Quaternary deposits are found near the mouth of the watershed, which is several miles south of Trinidad, California. The Redwood Creek Schist is mostly composed of hard, fine-grained quartz-mica schist, which includes or grades locally into bodies of semi-schist, slate, meta-conglomerate, and meta-chert (Kilbourne 1983-85; Harden et al., 1981). The Snow Camp Mountain geologic unit is composed of hard, intensely folded greywacke sandstone and siltstone that grades into sheared melange. The Undifferentiated Central Belt is composed of sandstone and mudstone. The Quaternary deposits are composed of poorly consolidated interbedded clays, silts, sands, and gravels.

Marine terrace deposits of late Pleistocene and Holocene age cover bedrock surfaces on wave-cut benches, within about three miles of the coastline and up to 500 feet above sea level near the mouth of Little River. The terrace deposits are composed of unconsolidated to slightly consolidated silts, sands, and gravels, including old dune sands. Holocene alluvium and floodplain deposits cover the valley floor, nearly one mile wide, in the area downstream from Crannell (Ristau 1979; Kelley 1984).

The inactive Bald Mountain Fault is located between the Snow Camp Mountain and Redwood Creek Schist geologic units, and the active Trinidad Fault separates these relatively young strata from the adjacent Franciscan Mélange.

The HPA generally is characterized by moderate to high relief hillslopes, except for the area from the Crannell town site to the mouth of the river at Moonstone Beach. Green Diamond's preliminary landslide data indicate that both shallow and deep-seated landslides exist throughout this HPA.

#### **4.4.7.4 Climate**

Little River HPA has a similar weather pattern of most northern California coastal watersheds, typically wet winters and dry summers. At least 80% of the precipitation occurs between November and April. The coastal area receives about 50 inches annually, whereas interior parts of the watershed receive over 80 inches annually. Most of the precipitation falls as rain, although snow fall occurs at the higher elevations. Coastal marine fog is common during the summer months.

#### **4.4.7.5 Vegetation**

The Little River HPA extends inland from the coast approximately 12 miles and reaches an elevation of 3360 feet. Aside from residential and agricultural development along U.S. Highway 101, the entire HPA is forested, with no natural prairies or other non-forest openings.

Sitka spruce and Douglas-fir/spruce forests along the coastal face give way within a mile or two of the coast to redwood and redwood/Douglas-fir forests. Minor amounts of grand fir, western red cedar, and western hemlock occur on lower slopes near the coast and in riparian zones. All but the extreme eastern tip of the HPA (approximately the last mile or two of the main stem of Little River) is within the summer fog zone. This area supports redwood as a significant, if not dominant, stand component. Above that limit, Douglas-fir and tanoak dominate the landscape. Red alder is the most common hardwood found in riparian zones throughout the HPA.

#### **4.4.7.6 Current Habitat Conditions**

##### **4.4.7.6.1 Water Temperature**

Water temperature monitoring in streams on the Original Assessed Ownership in the Little River HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 44 summer temperature profiles were recorded at 14 sites in 11 Class I watercourses. An additional 28 summer temperature profiles were recorded at 8 headwater sites in 8 Class II watercourses. Figure 4-26 displays the 7DMAVG water temperatures for each of the monitored sites in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results indicate that none of the Class I or Class II monitoring sites exceeded the red or yellow light threshold.

##### **4.4.7.6.2 Channel and Habitat Typing**

Louisiana-Pacific (LP) conducted channel and habitat assessments in 1994 on four streams in this HPA. The assessed streams (in descending order of mid-point watershed area), their mid-point watershed areas, and their gradients are as follows (see Appendix C1 for details and Table C1-6 for summary of data collected).

<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
Mainstem Little River	9,475 acres	3.0%
Upper South Fork Little River	3,095 acres	3.1%
Lower South Fork Little River	2,611 acres	1.6%
Railroad Creek	1,205 acres	2.9%

The results of the assessments are summarized below and depicted in Figure 4-27 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

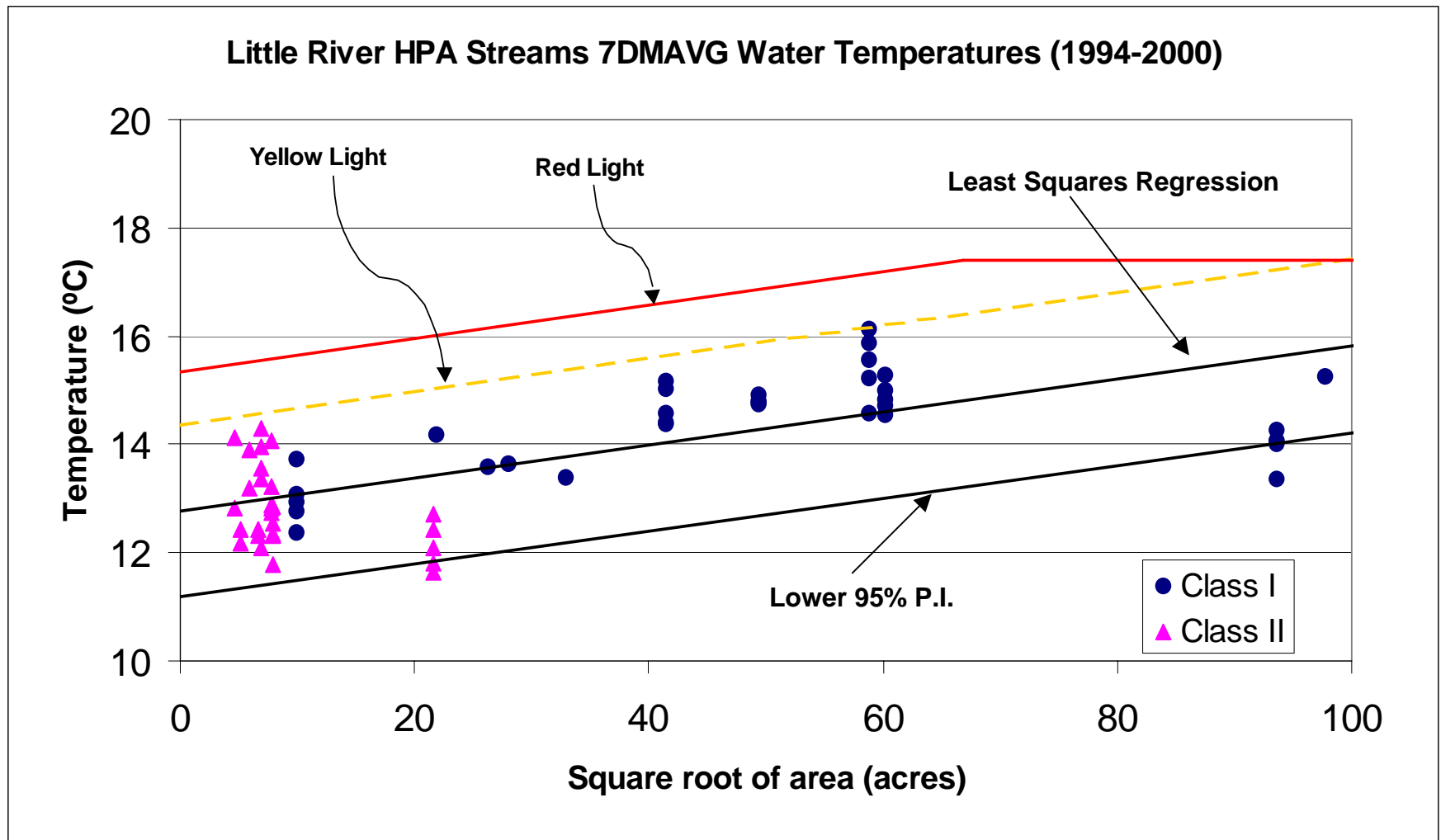
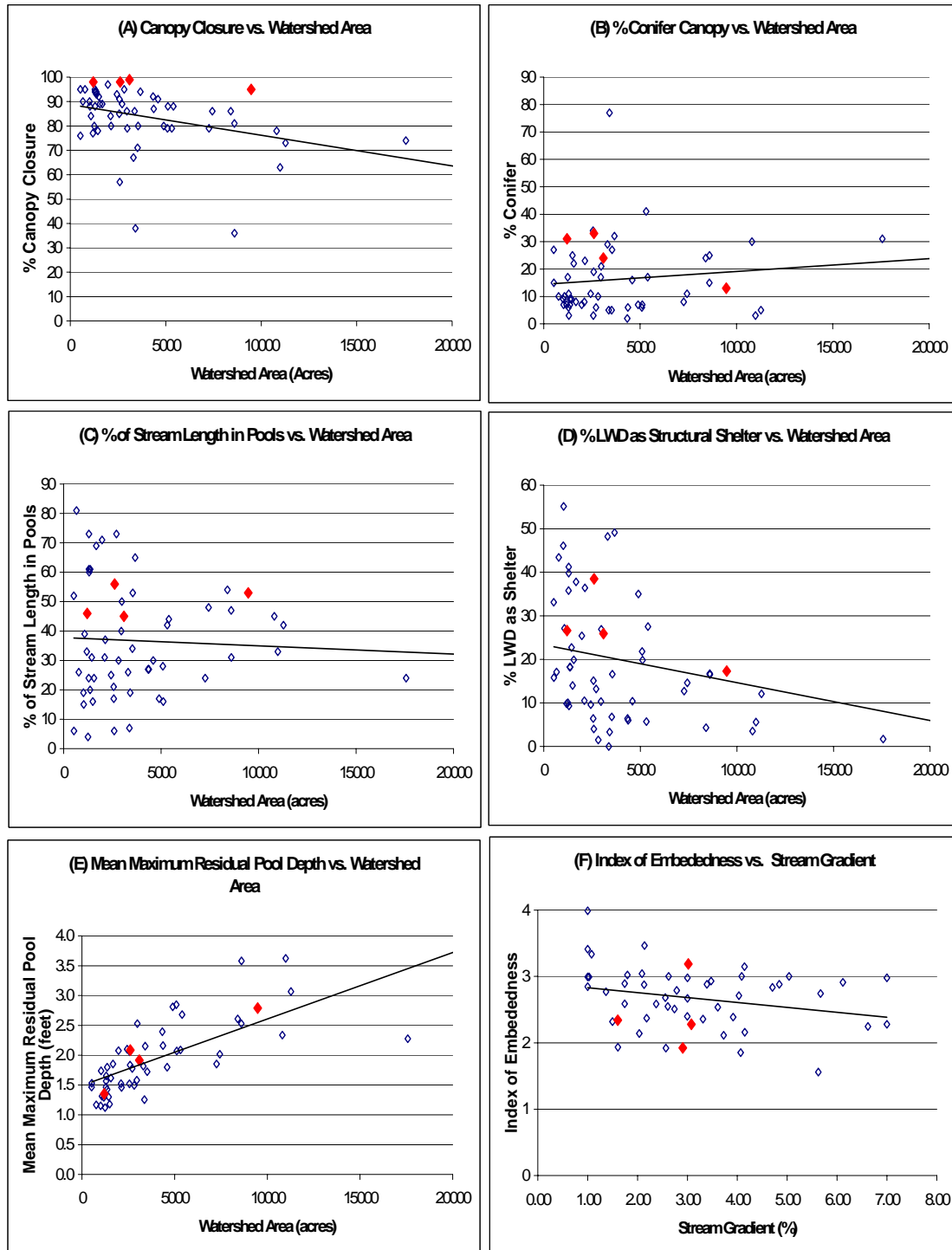


Figure 4-26. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Little River HPA monitored between 1994 and 2000.



**Figure 4-27.** Channel and habitat types in four streams assessed in the Little River HPA. (Solid diamonds are assessed streams in Little River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

The results indicate the following regarding the four assessed streams in this HPA:

- Percentage canopy cover for the four assessed streams is very high (95-99%) and includes some of the highest percentages for all assessed streams regardless of watershed area (Figure 4-27 [A]).
- Except for the mainstem Little River, the percentage of conifer canopy is greater for the assessed streams in this HPA (23%-33%) than for most other assessed streams with similar watershed area (Figure 4-27[B]). The conifer canopy for mainstem Little River (13%) is lower than that for many other assessed streams of similar watershed area (see Figure 4-27[B]). Compared with all assessed streams with similar watershed areas, the assessed streams in this HPA generally had greater percentages of stream length in pools (45%-56% by length) (Figure 4-27[C]). Except for Lower South Fork Little River, the percentage of LWD as structural cover in pools for the four streams is typical of that for most other assessed streams with comparable watershed size (Figure 4-27[D]).
- As shown in Figure 4-27[E]) the average residual pool depths in the four streams are variable but similar to other assessed streams. With the exception of mainstem Little River, the assessed streams in this HPA have somewhat lower substrate embeddedness indices than other assessed streams, regardless of stream gradient (Figure 4-27[F]). Little River has one of the greatest embeddedness indices for any of the Plan Area streams surveyed.

In summary, the results suggest that the habitat within the four assessed streams of the Little River HPA are, in many instances, similar to other assessed streams of similar watershed area. There are, however, some habitat differences. The four streams have higher canopy cover percentages on average than other streams of similar watershed size, and 3 of the 4 have higher percentages of conifer cover along the riparian margins. The 4 assessed streams in this HPA also have somewhat less embedded substrates than many other assessed streams of similar watershed area.

#### 4.4.7.6.3 LWD Inventory

LWD survey/inventories were conducted in 1994 and 1995 in four streams within the Little River HPA: mainstem Little River, Upper South Fork Little River, Lower South Fork Little River, and Railroad Creek. (See Appendix C2 for details and Tables C2-4 and C2-11 for summary of data collected.) Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD. The results of these investigations are summarized below and presented in Figure 4-28 (A-B).

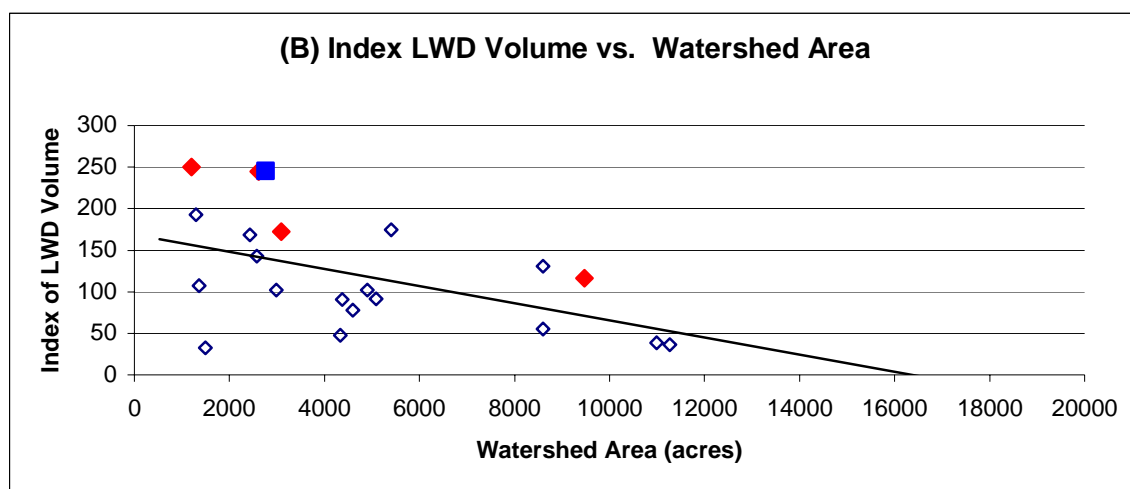
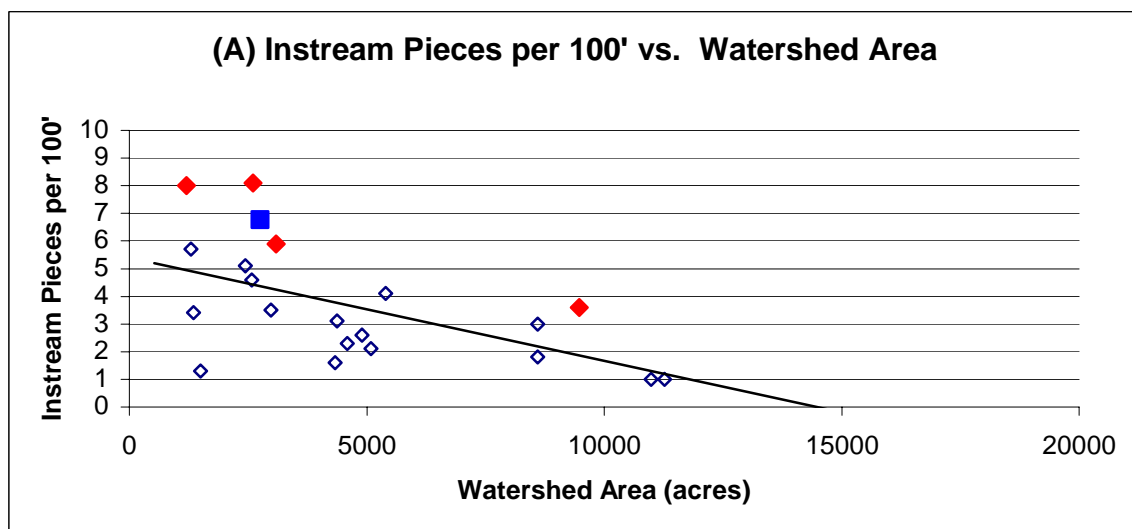


Figure 4-28. LWD survey results for four streams assessed in the Little River HPA. (Solid diamonds are assessed streams in Little River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)

- As shown in Figure 4-28 (A), the average in-stream LWD piece counts per 100 feet of channel for Upper South Fork Little River, Lower South Fork Little River, and Railroad Creek are much greater than those for all other assessed streams. The LWD counts per 100 feet of channel for these streams ranged from 5.1 to 8.1 pieces, which is 80% to more than 100% of the average for Prairie Creek. Counts of LWD pieces per 100 feet of stream channel in Little River were also greater than other assessed streams with similar watershed areas, but to a lesser magnitude than the three other streams assessed in this HPA (see Figure 4-28 [A]).
- LWD volume indices for Upper South Fork Little River, Lower South Fork Little River, and Railroad Creek are greater than those for other assessed streams with similar watershed area (Figure 4-28 [B]). Little River also had a greater LWD volume index area than other streams with comparable watersheds within the Plan area but to a lesser extent than the three other assessed streams.

In summary, the four assessed streams in this HPA have the highest average LWD piece counts per 100 feet of channel and volume indices for their watershed size of all assessed streams on the Original Assessed Ownership.

#### **4.4.7.6.4 Estuarine Conditions**

The Little River estuary has been impacted to a certain degree by human activities. Livestock grazing has denuded some of the riparian zone along the lower channel, accelerating the erosion of streambanks. In spite of this, the Little River has more estuarine habitat than many local streams of its size, and surveys have indicated utilization of the estuary by juvenile chinook salmon (LP 1986, CDFG 1986). Although Little River is a relatively small watershed, its mouth rarely, if ever, bars over during the summer to form an enclosed lagoon.

#### **4.4.7.7 Salmonid Population Estimates**

The Little River HPA is currently the most actively surveyed HPA for adult spawning escapement. However, spawner surveys on these streams have only been conducted since 1998, since the acquisition of the LP holdings. The mainstem Little River has the highest totals of both redds, live fish, and carcasses. The second largest spawner counts have been observed on Lower South Fork Little River. The majority of spawning activity appears to be by chinook; however, coho and steelhead are occasionally observed during surveys. Although these surveys would indicate very little spawning activity by these species, juveniles of these species are extremely abundant during summer juvenile dive counts and out-migrant trapping, indicating a fair number of adults may not be observed during spawner escapement surveys. This is often a result of survey limitations due to high flows, which may reduce visibility and flush carcasses out of the system. Survey frequency and timing are important, but even with the increased surveys adult salmonids will be missed, making it very difficult to rely on adult counts as an intricate component of the monitoring program.

#### 4.4.7.7.1 Summer Juvenile Population Estimates

A summary of juvenile coho salmon, steelhead, and cutthroat trout summer population estimates for Railroad Creek, Lower South Fork Little River, and Upper South Fork Little River for 1998-2000 are shown in Figure 4-29 (A-C respectively).

As seen in Figure 4-29 (A) the juvenile coho salmon population estimate in Railroad Creek ranged from 176 to 339 during these three years. Steelhead estimates ranged from 76 to 115 juveniles. Estimates of juvenile cutthroat trout populations in Railroad Creek could only be made in 1998. No coastal cutthroat trout were observed in 1999 and 2000 (see Figure 4-29[A]). The estimated numbers of juvenile coho salmon for Lower South Fork Little River were much greater than the other streams surveyed in this HPA for all three years. The coho estimates in Lower South Fork Little River ranged from greater than 3,600 to nearly 8,000 juveniles for the three years (Figure 4-29[B]). However the number of juvenile steelhead were similar to those estimated for Railroad Creek and ranged from 62 to 230 during the three years of estimates. Coastal cutthroat trout estimates for Lower South Fork Little River were slightly better than those for Railroad Creek and ranged from 0 to 230 (see Figure 4-29[B]).

Coho salmon also dominated the populations in Upper South Fork Little River based on estimates made during 1998 through 2000 (Figure 4-29 [C]). Population estimates for coho ranged from 343 to 1,230 during those years. Estimated populations of juvenile steelhead were somewhat stable and overall were greater in Upper South Fork Little River compared to other streams surveyed in this HPA. Steelhead population estimates ranged from approximately 250 to 350 juveniles (Figure 4-29 [C]). As was the case with the other streams surveyed, cutthroat trout juvenile estimates were low (range = 0 to 7) in Upper South Fork Little River during the three years estimates were made.

In summary, the summer juvenile population estimates indicate that coho populations are variable but their populations appear to be robust and stable in the three streams surveyed in this HPA. Steelhead populations, while less than those estimated for coho salmon, also appear to be somewhat stable between years and streams surveyed in this HPA. Summer population estimates for cutthroat indicated there are small numbers of juveniles of these species, and some variability from year to year in the streams surveyed.

#### 4.4.7.7.2 Out-migrant Trapping

Juvenile salmonid outmigrant smolt trapping was conducted on Little River tributary streams during 1999 and 2000 (see Section 4.3 and Appendix C8 for details). Results are shown in Figure 4-30(A-C).

The results of population estimates from coho salmon outmigrant trapping during 1999 and 2000 and corresponding previous summers' population estimates (1998 and 1999) are shown in Figure 4-30 (A and B). These results indicate that there is a great deal of variability between Little River tributaries within a single trapping year as well as between years.

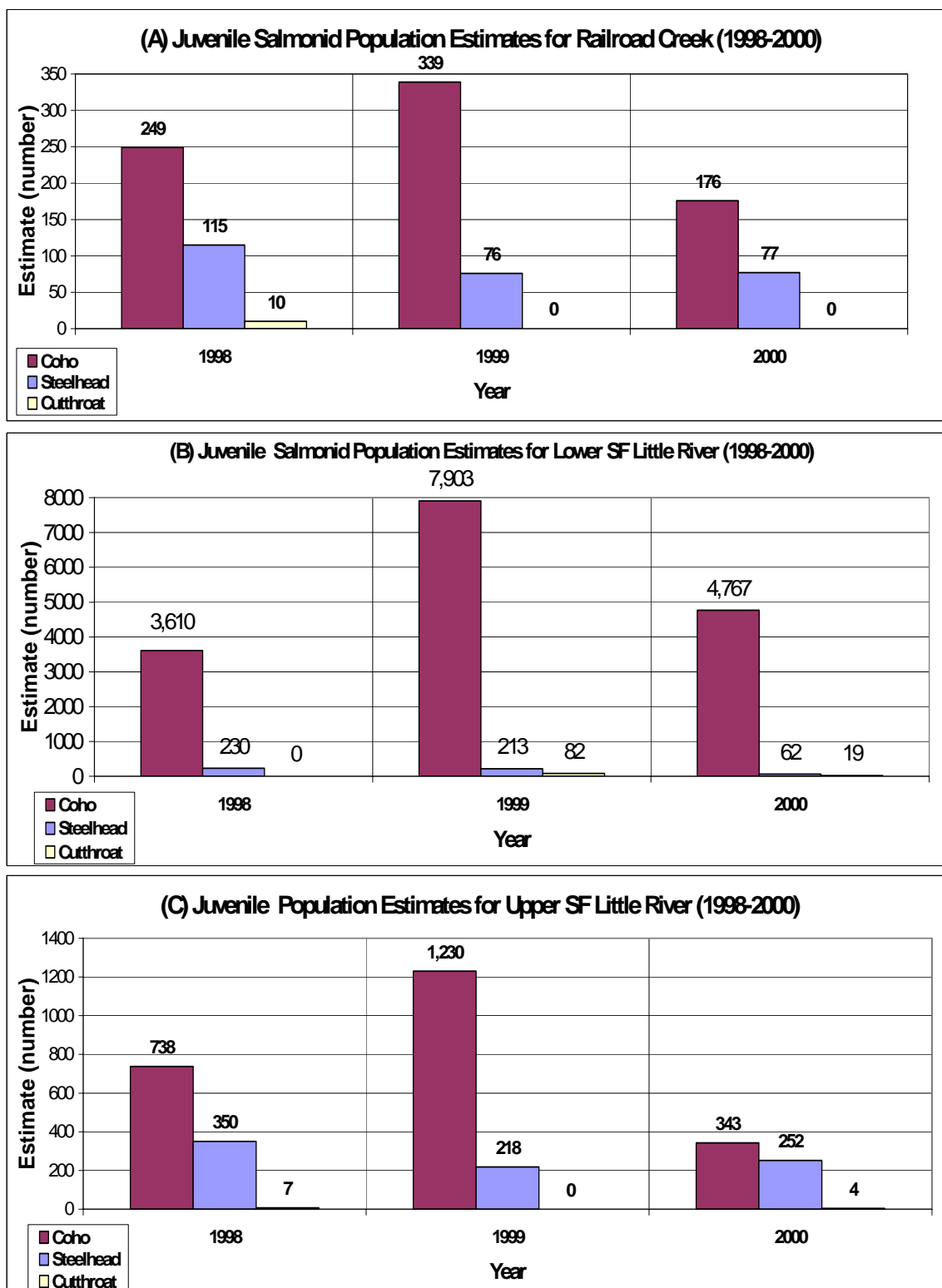


Figure 4-29. Summary of the juvenile population estimates for coho salmon, steelhead, and cutthroat trout, in the 3 Little River HPA streams surveyed in 1998, 1999, and 2000.

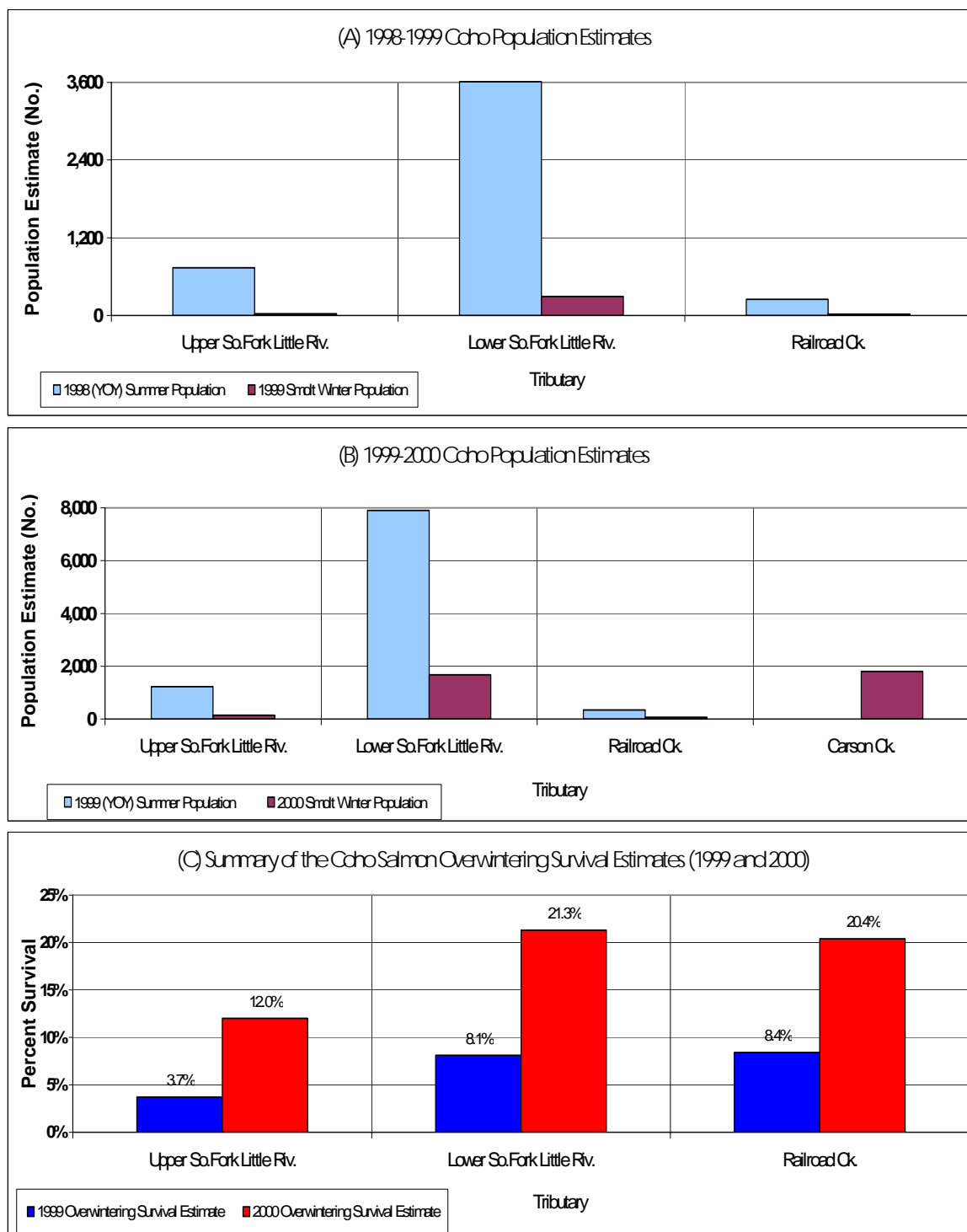


Figure 4-30. Summary of the summer and winter juvenile coho salmon population estimates and over-wintering survival estimates for tributaries of Little River (1998-1999 and 1999-2000).

In general, summer populations of coho salmon in Lower South Fork Little River were much greater than other tributaries during both 1998 and 1999. The over-wintering survival percentages for coho during 1999 for all 3 tributaries were from one-third to approximately one-half of those for 2000 (Figure 4-30 [C]). This may indicate that habitat conditions in Little River tributaries were more suitable for coho during 2000 as compared to 1999. Furthermore, when comparing the over-wintering survival to the other tributaries (Lower South Fork Little River and Railroad Creek) during both years, Upper South Fork Little River had approximately ½ the rate of over-wintering survival (see Figure 4-30[C]). This indicates that habitat conditions in Upper South Fork Little River may have been less suitable than those in the other tributaries during both years.

Outmigrant smolt population estimates for coho, steelhead and cutthroat trout for 1999 and 2000 are shown in Figure 4-31. Coho salmon dominated the outmigrant smolt estimates in Lower South Fork Little River and Carson Creek in 2000, exceeding 1,600 and 1,800 smolts respectively. Except for coho in Lower South Fork Little River during 1999, all other outmigrant smolt populations for other tributaries and species were less than 200 smolts for 1999 and 2000.

The use of outmigrant trapping appears to be an excellent tool for collecting information pertaining to coho production in the Little River drainage. The use of this trapping system efficiently samples streams during low and normal stream flows. The outmigrant trapping program is in preliminary stages however, and it is too early to determine population trends for the results of 2 trapping seasons.

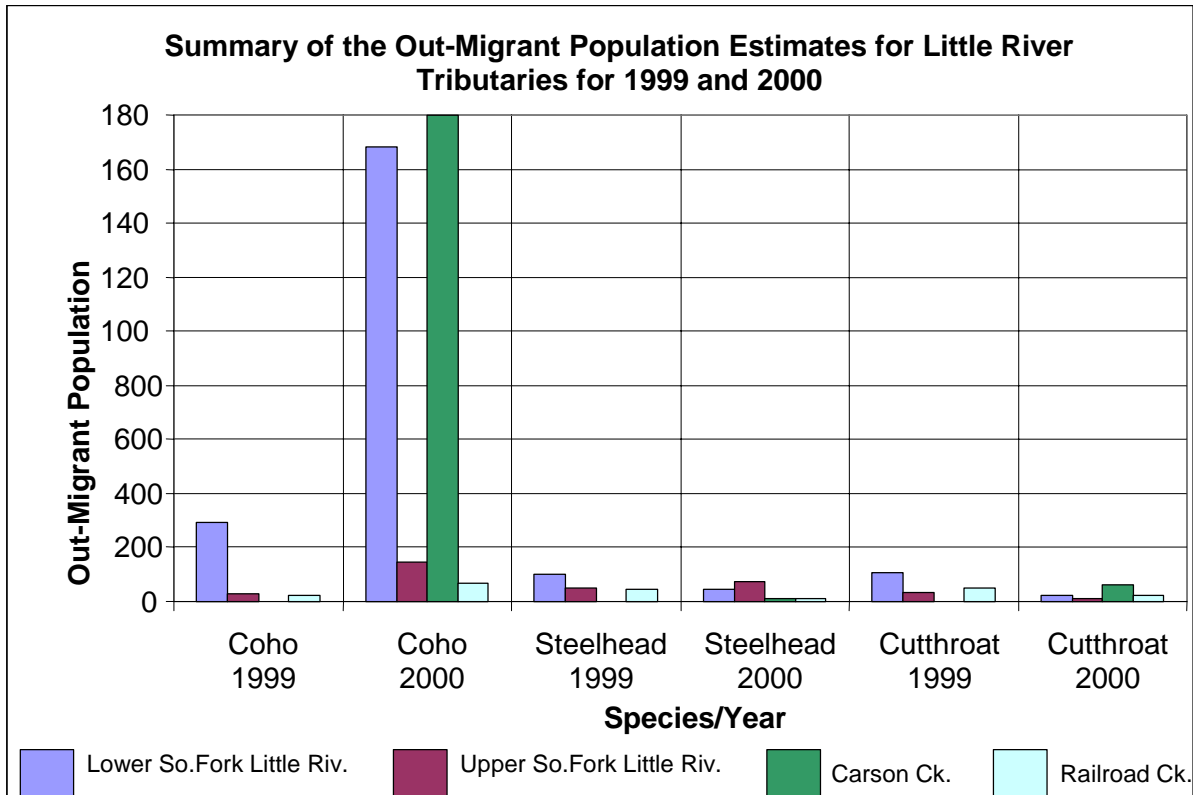
#### 4.4.7.7.3 Adult Spawner Escapement Surveys

Spawning surveys have been conducted on 6 streams within the Little River HPA during the period of 1998 through 2000 (see Appendix C9 for details). The streams and years surveyed are:

- Carson Creek: 1998-1999
- Danielle Creek: 1998-1999
- Mainstem Little River: 1998-1999 and 1999-2000
- Lower South Fork Little River: 1998-1999 and 1999-2000
- Upper South Fork Little River: 1998-1999 and 1999-2000
- Railroad Creek: 1998-1999 and 1999-2000

The results to date indicate that no salmonids were observed spawning in Danielle Creek during 1998-1999 and only a few un-identified redds and carcasses were observed in Carson Creek during those surveys. In addition, in Railroad Creek only a small number of unidentified redds that were observed during the 1999-2000 surveys and none observed during the 1998-1999 surveys.

A good number of live chinook, chinook carcasses, and redds (1998-1999 and 1999-2000), and to a lesser degree live adult steelhead and redds (1999-2000) were observed in the mainstem Little River. Live coho adults and carcasses and steelhead carcasses were infrequently observed during both years, but a large number of un-identified redds were observed during the 1998-1999 and 1999-2000 escapement surveys in Little River.



**Figure 4-31. Summary of salmonid out-migrant population estimates for tributaries of Little River (1998-1999 and 1999-2000).**

In the Upper South Fork Little River, small numbers of live chinook salmon, unknown carcasses, and redds were observed during the 1998-1999 and the 1999-2000 surveys. The Lower South Fork Little River surveys revealed a few live adult chinook, coho, and steelhead and (to a lesser degree) redds and carcasses of those species in 1998-1999. In 1999-2000 and 1998-1999, a good number of unidentified redds were observed in the Lower South Fork Little River during surveys. In summary, variable numbers of all three of these species have been observed spawning in the streams surveyed in the Little River HPA.

#### **4.4.7.8 Covered Species Occurrence and Status**

Presence/absence of the six Covered Species in the Little River HPA is presented by drainage in Table 4-10, and the recorded distribution is displayed in **Figure 4-32**.

**Table 4-10. Covered Species distribution in the Little River HPA.**

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Little River	2,3	1,2,3	2,3	2,3	3	3
Bullwinkle	A	A	U	U	U	U
Coon	A	A	U	U	U	U
South Fork Little River	3	1,2,3	2,3	2,3	P	3
Water Gulch	A	A	U	P	U	U
Freeman Cr.	A	3	P	3	P	P
Railroad	3	3	3	3	3	3
Lower South Fork Little River	2,3	1,2,3	2,3	2,3	3	3
Danielle Cr.	A	3	3	3	P	3
Heightman	P	3	P	3	P	P
Upper South Fork Little River	2,3	1,2,3	2,3	2,3	3	3
C-Line Cr.	A	A	3	3	P	P
Pattie's Cr	A	A	3	3	P	P
<b>Codes</b> U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT= resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records						

#### 4.4.7.8.1 Chinook Salmon

The Little River HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA as of September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the listing decision (64 FR 50405).

The Little River chinook population is depressed compared to historical estimates, but recent trends show a relatively stable population. Green Diamond has observed small numbers of live adult and carcasses of spawned out chinook salmon as well as redds during spawning surveys conducted within the Little River during 1998-2000. Other tributaries to Little River (Upper South Fork and Lower South Fork Little River) had many fewer numbers of spawning chinook salmon observed during those surveys. The Little River is considered one of the best local salmonid streams, with healthy genetic stocks, sufficient returns to seed the system, and good salmonid habitat (Weseloh and Farro, pers. comm. 1999).

#### 4.4.7.8.2 Coho Salmon

Coho salmon populations are depressed throughout the Southern Oregon/Northern California Coasts Coho ESU, which encompasses the Little River HPA. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995). This ESU was listed as threatened in May 1997.

The Little River coho population is depressed compared to historical estimates but appears to be relatively stable over the last decade. Recent data indicates high numbers and densities of juvenile coho from the 1998-99 brood year (see Appendix C). Spawning surveys conducted by Green Diamond have resulted in observations of live adult, carcasses of spawned out coho salmon, and coho redds within Little River during 1998-2000 and to a lesser degree in the Lower South Fork Little River during 1998-1999. The Little River is considered one of the best local salmonid streams, with healthy genetic stocks, sufficient returns to seed the system, and good salmonid habitat (Weseloh and Farro, pers. comm. 1999)

#### 4.4.7.8.3 Steelhead and Resident Rainbow Trout

The Little River HPA includes the Northern California Steelhead ESU, which was listed as threatened on June 7, 2000 (65 FR 360744). Steelhead abundance data are limited for this DPS. Available data indicate that winter-run populations declined significantly prior to 1970 and that populations have remained at depressed levels with no clear trends since then (Busby et al. 1996).

Specific information on steelhead populations in the Little River HPA indicates that the Little River has been and remains an excellent system for steelhead production, although current abundance is depressed compared to historical estimates. Out-migrant trapping conducted by USFWS in 1994 captured approximately 10,000 steelhead parr and 1100 smolts (Shaw and Jackson 1994). The ability of steelhead to utilize spawning and rearing habitat upstream of other salmonids in the Little River contributes to their success in this HPA (Weseloh and Farro, pers. comm. 1999)

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.7.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Specific information on coastal cutthroat trout populations in the Little River HPA is limited to recent estimates and observations. Historical information for comparison is lacking. Out-migrant trapping in the mainstem Little River in 1994 captured 403 coastal cutthroat, ranging in size from 50 to 275 mm, with the bulk around 150 mm (Shaw and Jackson 1994). A summary of recent outmigrant smolt trapping population estimates is shown in Figure 4-32 above. When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### 4.4.7.8.5 Tailed Frog

Green Diamond's ownership in the Little River HPA was acquired in 1998 after the presence/absence surveys for tailed frogs were completed. Sampling was not conducted in this HPA as part of the study of 72 streams. However, populations of tailed frogs have

been confirmed in 15 streams throughout the HPA either through other types of amphibian surveys by the prior landowner or incidental observations since the acquisition of the property by Green Diamond.

Given the significant number of streams known to support the species, tailed frogs streams in the Little River HPA are likely to be in good condition.

#### **4.4.7.8.6 Southern Torrent Salamander**

Green Diamond's ownership in the Little River HPA was acquired in 1998 after the presence/absence surveys for southern torrent salamanders were completed. Sampling was not conducted in this HPA as part of the study of 71 streams. However, populations of southern torrent salamanders have been confirmed in 18 streams throughout the HPA either through other types of amphibian surveys by the prior landowner or incidental observations since the acquisition of the property by Green Diamond.

Given the significant number of streams known to support the species, southern torrent salamander streams in the Little River HPA are likely to be in good condition.

#### **4.4.7.9 Assessment Summary**

Due to the coastal influence and high canopy closure, water temperatures are good in streams throughout the Original Assessed Ownership in the Little River HPA. The HPA has mixed geologic composition, characteristic of the Franciscan Complex. However, much of it is relatively stable compared with many of the other HPAs, and the parent material is relatively competent (consolidated) so that substrates are relatively coarse in most streams. Exceptions are found in some of the more extreme coastal sub-basins, such as Bullwinkle and Coon Creeks, where unconsolidated material results in a fining of the bed. The amount and quality of pool habitat and the overall amount of LWD in assessed streams in this HPA is the highest of all assessed streams on the Original Assessed Ownership. In addition, embeddedness was generally estimated lower than in assessed streams in most other HPAs, but this measure is highly subjective and may not be reliable. Green Diamond's qualitative assessment is that some streams on the Original Assessed Ownership in this HPA have relatively high levels of fine sediment including the mainstem Little River.

All of the salmonid species Covered Species are well distributed in streams on the Original Assessed Ownership in the Little River HPA, and the population levels are generally the highest among all assessed streams, particularly for coho salmon. This appears to be consistent with the generally good habitat conditions in Class I watercourses on the Original Assessed Ownership in this HPA. In contrast, the amphibian Covered Species do not appear to be particularly widespread in the Original Assessed Ownership in this HPA. However, as noted above, the ownership in this HPA was acquired by Green Diamond in 1998 after the amphibian surveys were completed. Green Diamond's qualitative assessment is that many of the headwater streams have excess sediment inputs from roads, which degrades the habitat for the amphibian Covered Species.

Given that sediment inputs have the potential to have a negative impact on both the salmonid and amphibian Covered Species, the highest conservation priority for the Plan Area in this HPA should be to address road-related sediment inputs.

#### **4.4.8 Mad River HPA**

##### **4.4.8.1 HPA Type, Size, and Group**

The Mad River HPA is a hydrographic area as defined in this Plan and is part of the Korbelt HPA Group. It includes approximately 119,686 acres.

##### **4.4.8.2 Eligible Plan Area**

The Eligible Plan Area in the Mad River HPA includes approximately 99,163 acres: 49,376 acres of Initial Plan Area and 49,787 acres of Adjustment Area. All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

##### **4.4.8.3 Geology**

The Mad River HPA is within the Coast Ranges Geologic Province (see **Figure 4-1**). Bedrock in this HPA is composed mostly of Central Belt Franciscan Complex and Quaternary – Tertiary Overlap deposits, juxtaposed by the Mad River thrust fault system.

Topography in the HPA is relatively steep and mountainous, but fairly extensive lowlands are present from the mouth of the river and upstream to the Mad River Hatchery, near the town of Blue Lake.

Central Belt Franciscan complex is composed of broken formation (schist, greywacke sandstone, shale, conglomerate, chert, pillow basalt, and greenstone) and mélangé (primarily composed of discontinuous bodies of hard greywacke sandstone, chert, greenstone and pillow basalt in a weak, pervasively sheared claystone matrix). However, mapping of the units has not been systematic and consistent in all parts of the watershed. In much of the area, the Franciscan units have not been separately identified, and the rock is simply mapped as Undifferentiated Franciscan.

Quaternary – Tertiary Overlap deposits include the Falor Formation, which is generally described as poorly cemented clay, silty clay, and pebbly sandstone and fine-grained sandstone with pebbly stringers (James, 1982). The Falor Formation is correlated to the upper section of the Wildcat Group (James, 1982). Other Quaternary – Tertiary Overlap deposits include marine terraces, fluvial terraces, dune deposits, and Holocene alluvium and beach deposits.

Pleistocene to Holocene marine terrace deposits cover the bedrock surfaces on wave-cut benches within about two miles of the coastline, and up to 260 feet above sea level. These deposits are composed of slightly consolidated silts, sands and gravels, which have been uplifted and offset by subsequent fault movements (Kelley 1984; Kelsey and Carver 1988).

Pleistocene to Holocene fluvial terrace deposits cover the bedrock at various locations adjacent to the present stream and river channels, but at higher levels than the active channel deposits. As many as six separate terrace levels have been identified at some

locations, with progressively older terrace deposits at correspondingly higher levels. These deposits are composed of unconsolidated, poorly sorted sands, gravels and boulder conglomerates. Fluvial terrace deposits are most extensive adjacent to Lindsay Creek in the Fieldbrook area and adjacent to the Mad River at Blue Lake and Butler Valley (Kelley 1984; James 1982; Kilbourne 1983-85).

Ancient dune sand deposits of Pleistocene to Holocene age overlie the bedrock up to four miles from the present coastline and up to 620 feet above sea level. These deposits are composed of unconsolidated fine to coarse grained sand (Kelley 1984). The ancient dune sands may be part of the Hookton Formation located south of the area covered in this study. These materials are extremely erodible where they are exposed, and they are subject to slumping where slopes are undercut.

Holocene alluvium, flood plain deposits and beach deposits are present in active stream and river channels, in valley bottoms and on the coastal plain. They are composed of poorly sorted, unconsolidated mixtures of boulders, gravel, sand, silt and clay (James 1982; Kelley 1984; Kilbourne 1983-85; Ristau 1979). These deposits are reworked by meandering and shifting stream channels, especially during the infrequent large flood events. The sediment progressively migrates downstream, with new material being added at multiple points along the channels by erosion and landslide movement. Some of that new material is transported out to sea or removed by gravel mining.

The construction of two dams, and the later removal of one of them, has modified the sediment migration pattern in the Mad River system. Sweasey dam was constructed about seven miles upstream from Blue Lake in 1938. By 1960, its 3,000 acre-foot reservoir was nearly filled with gravel, sand and silt. The dam was removed in 1970, releasing the sediment (almost five million cubic yards) for subsequent movement downstream. That pulse of material is still affecting the river channel below the dam site. Robert Matthews Dam at Ruth Reservoir was constructed in 1961, with a capacity of 51,800 acre-feet. Sediment is accumulating in the reservoir at a comparatively minuscule rate because it is located far upstream where the sediment load is very low (James 1982).

Published geologic maps indicate that both shallow and deep-seated landslides exist throughout this HPA. Deep-seated rotational/translational landslides and earthflows are common in the Franciscan mélange. Younger bedrock in the area is highly erodible and susceptible to slumping and rotational slide movement.

#### **4.4.8.4    *Climate***

In the Mad River basin, 75% of the annual precipitation occurs between November and March. Snow usually occurs above 3000 feet, but snow levels may occasionally drop to as low as 1000 feet above sea level. Annual precipitation levels range from around 40 inches at the coast to greater than 70 inches in the central basin. The basin average is approximately 63 inches.

The four largest recorded flood events were on January 1953, December 1955, November 1960 and December 1964. The highest recorded peak discharge was during the 1955 event: 77,800 cfs. at the Arcata gauge station.

#### **4.4.8.5 Vegetation**

The Mad River HPA extends inland from the coast approximately 26 miles and reaches an elevation of 5200 feet. It encompasses a range of vegetative types from coastal scrub and Sitka spruce forest in the coastal area to Douglas-fir/white fir forests at elevations above 4000 feet in the extreme southeastern corner of the HPA.

Redwood/Douglas-fir forests dominate roughly the lower two-thirds of the HPA. This type also includes occasional grand fir, western red cedar, and western hemlock on lower slopes near the coast. Red alder is the most common hardwood in riparian zones, and tanoak is the most common mid to upper slope hardwood, with pacific madrone occurring as a minor stand component on drier sites. As distance from the coast and elevation increase, the proportion of redwood in stands decreases and Douglas-fir and tanoak become more prevalent, with these species dominating the landscape at elevations above 2000 feet. Occasional incense cedar is also found at higher elevations along the HPA's western boundary.

Extensive prairies are particularly distinctive features on south to west slopes and ridgetops in the upper one-third of the HPA. In this area California black oak forms nearly pure stands as an ecotone between prairies and Douglas-fir forest.

Timber harvesting in this HPA began in the late 1800s near the coast as white settlers arrived. By 1930 almost all of the redwood type had been harvested. The Douglas-fir dominated forests in the upper reaches of the HPA were not extensively logged until the 1940s, and by 1970 very little timberland remained in the HPA that had not been logged. Harvesting of mature second-growth forests was initiated in the lower reaches of the HPA in the 1960s.

#### **4.4.8.6 Current Habitat Conditions**

##### **4.4.8.6.1 Water Temperature**

Water temperature monitoring in the Mad River HPA began in 1994 and is ongoing today (see Appendix C5 for details). From 1994-2000, 37 summer temperature profiles were recorded at 11 sites within 9 Class I watercourses in the HPA. An additional 53 summer temperature profiles were recorded at 20 headwater sites within 14 Class II watercourses. Figure 4-33 displays the 7DMAVG water temperatures for each site in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for the period (1994-2000) indicate that 3 monitoring sites in one Class I watercourse (Cañon Creek) exceeded the red light thresholds 6 times: at the lowest monitoring site during 1996 through 2000 and at the mid reach site in 2000. In addition, one Class I site (Green Diamond Creek) exceeded the yellow light threshold in 1997 and 1999. No Class II sites exceeded the red or yellow light thresholds.

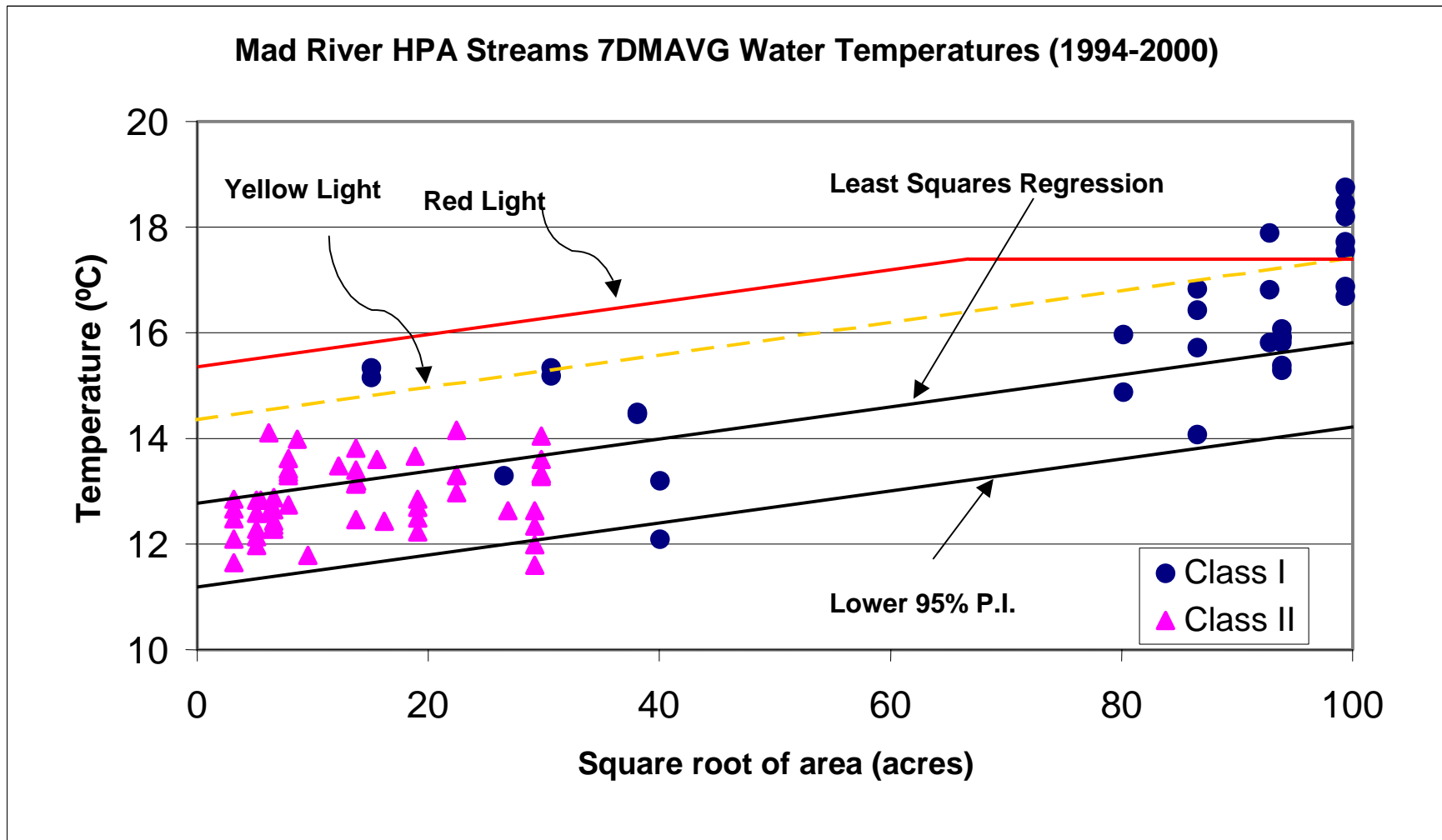


Figure 4-33. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Mad River HPA monitored between 1994 and 2000.

#### 4.4.8.6.2 Channel and Habitat Typing

Green Diamond assessed three streams in 1994-5 within the Mad River HPA. The assessed streams (in descending order of mid-point watershed area), their mid-point watershed areas, and their gradients are as follows (see Appendix C1 for details and Table C1-7 for summary of collected data):

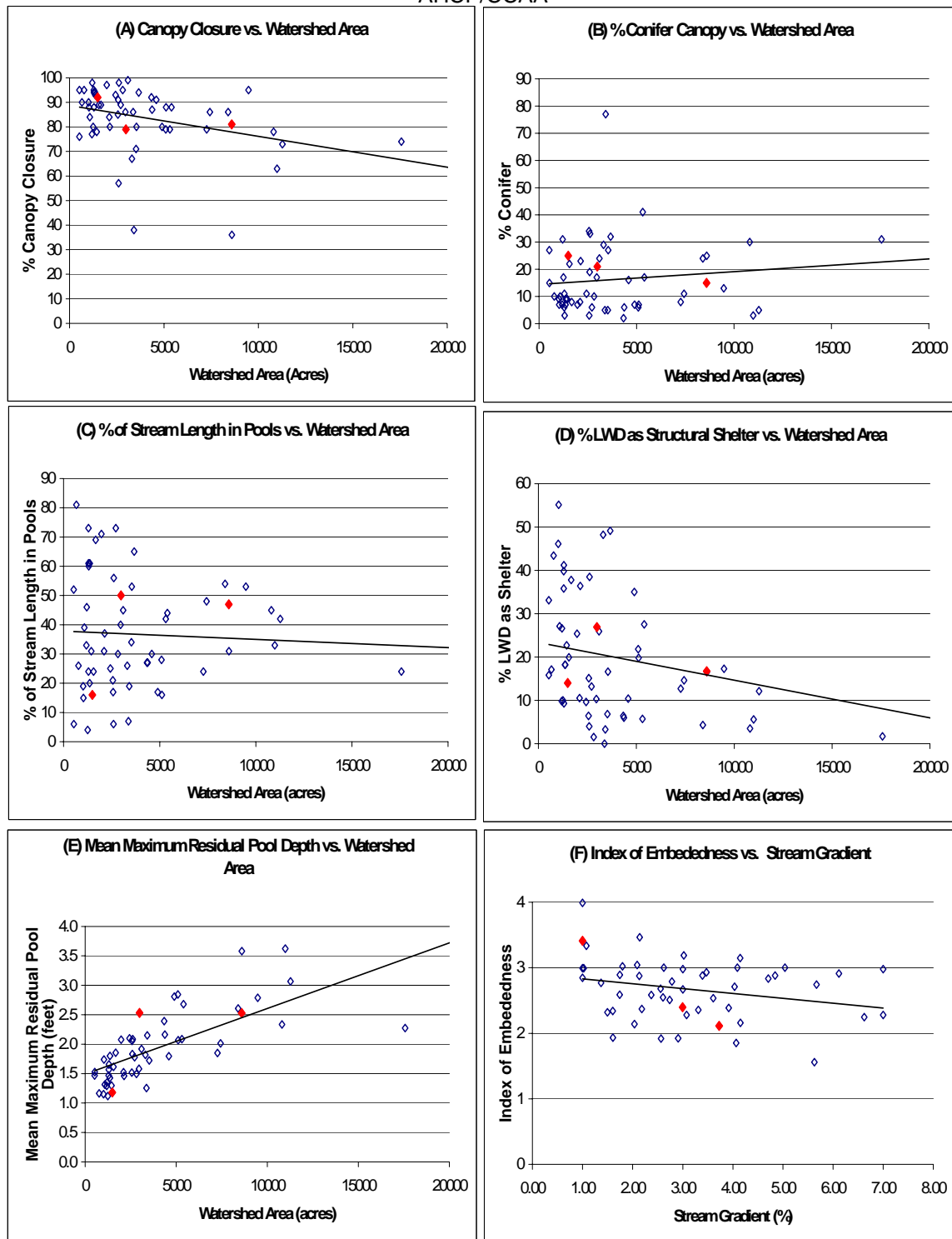
<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
Cañon Creek	8,595 acres	3.0%
Lindsay Creek	2,985 acres	1.0%
Dry Creek	1,492 acres	3.7%

The results of the assessments are summarized below and depicted in Figure 4-34 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

The results for the three assessed streams indicate:

- Percent canopy closure (79-92%) and percentage conifer canopy (15-25%) for the three assessed streams are somewhat typical of other assessed streams with similar watershed areas (Figure 4-34 [A and B]).
- For the three assessed streams, there was wide variability in percentage of stream length in pools (16-50%), but the percentages are generally similar to those for other streams of similar watershed area (Figure 4-30 [C]).
- The percentage of LWD as structural shelter in pools for the three streams varies widely (range 14-26.9%). Dry Creek's percentage (14%) is somewhat lower and Lindsey Creek's (26.9%) is somewhat greater than that for other assessed streams with similar watershed area (Figure 4-34 [D]).
- Figure 4-34 [E]) depicts the average residual pool depths in the 3 streams. Dry Creek (1,492 acres) has a lower and Lindsey (2,985 acres) has a much greater average residual pool depth than other assessed streams with similar watershed areas.
- Lindsey Creek has one of the highest embeddedness index values of all assessed streams on the Original Assessed Ownership (Figure 4-34 [F]).

In summary, the results suggest that the habitat in the assessed streams in the Mad River HPA are, in many instances, similar to other assessed streams of similar watershed size.



**Figure 4-34.** Channel and habitat types in three streams assessed in the Mad River HPA. (Solid diamonds are assessed streams in Mad River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

4.4.8.6.3

### LWD Inventory

LWD survey/inventories were conducted in 1994 and 1995 in three streams in the Mad River HPA: Cañon, Lindsey, and Dry creeks (see Appendix C2 for details and Tables C2-5 and C2-13 for summary of collected data.) Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD. The results of these investigations are summarized below and presented in Figure 4-35 (A-B).

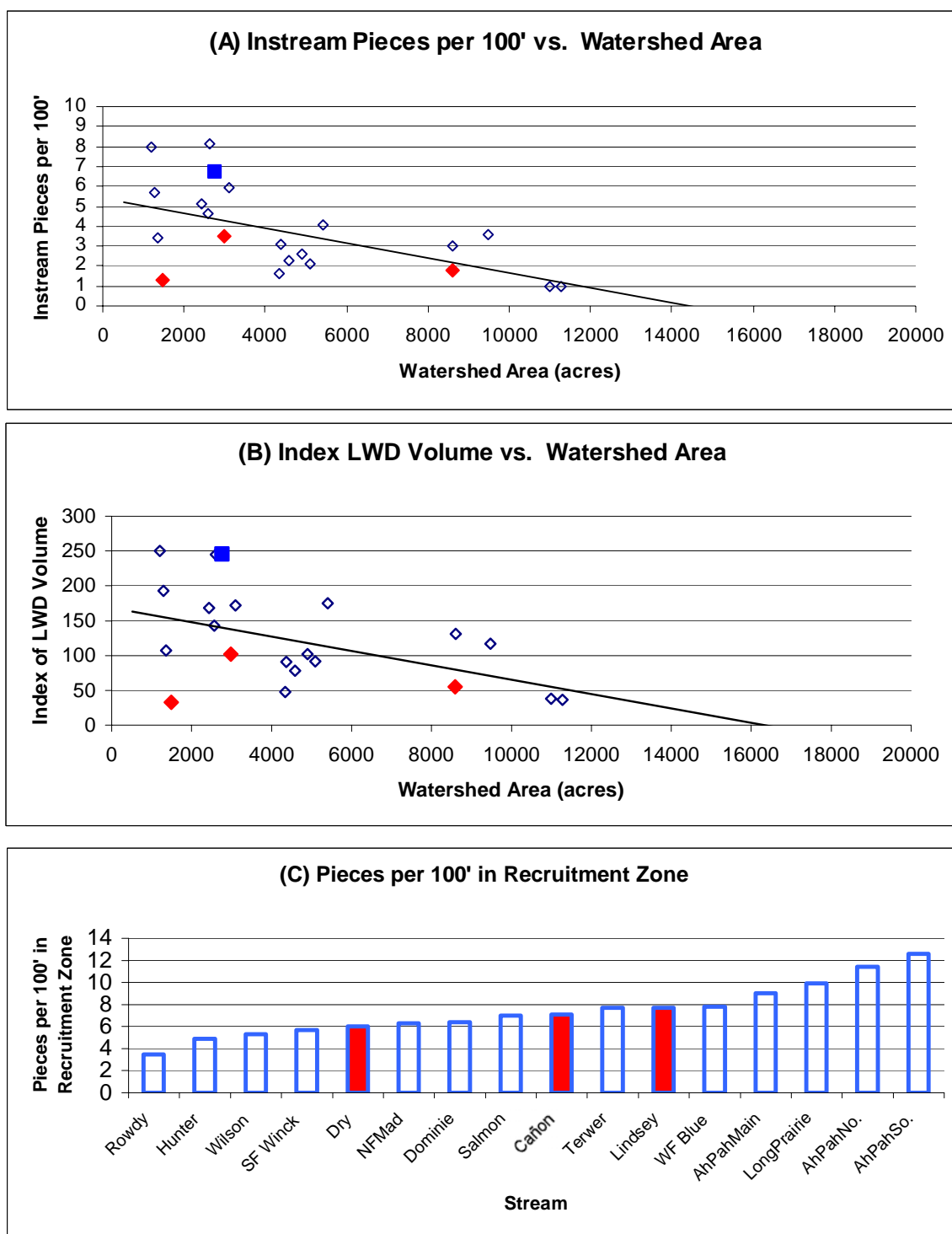
- As shown in Figure 4-35 (A), Dry and Lindsey creeks have somewhat lower numbers of average in-stream LWD pieces per 100 feet of channel than other assessed stream of similar watershed area. The average number of LWD pieces per 100 feet of channel is 1.3 for Dry Creek, 3.5 for Lindsey Creek, and 1.8 for Cañon Creek. The average for Prairie Creek is 6.8.
- The LWD volume indices for the three streams in the HPA are shown in Figure 4-35 (B). In general, the indices are also somewhat lower than those for other assessed streams with similar watershed areas.
- As shown in Figure 4-35 [C], the average number of LWD pieces in riparian recruitment zone per 100 feet for the three assessed streams in this HPA ranges from 6 to 7.7 and is similar to other assessed streams with comparable watershed areas.

In summary, the three assessed streams in this HPA have some of the lowest average LWD piece counts per 100 feet of channel and lowest volume indices for their watershed size of all assessed streams on the Original Assessed Ownership.

#### 4.4.8.6.4 Long Term Channel Monitoring

Using the information gathered in channel monitoring pilot studies that began in 1993, a revised methodology was developed and first implemented in Cañon Creek beginning in 1995. In 1996 and 1997, additional channel monitoring data was obtained from Cañon Creek. Re-surveys are scheduled to occur every two years or after a five-year flood event.

Appendix C3 provides the details of the surveys through 1997. Data collected in this HPA since 1998 are scheduled for analysis in 2003. Each monitoring reach should have at least 3 years of data prior to the first analysis and be updated biennially to coincide with the biennial report to the Services that will be prepared under this Plan. No conclusions can be drawn at this point in the monitoring program.



**Figure 4-35.** LWD survey results for three streams assessed in the Mad River HPA. (Solid diamonds are assessed streams in Mad River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)

#### **4.4.8.6.5 Estuarine Conditions**

The Mad River estuary has been severely impacted by human settlement, beginning with the draining and diking of wetlands for agricultural use. The Arcata Bottoms (once the Mad River floodplain) has been extensively developed for livestock grazing and residential purposes. In addition, to prevent regular flooding of this area, a meander in the lower Mad River was cut off by excavation of a new channel segment in 1862. The lower channel was cleared of large woody debris jams to facilitate transport of logs in the late 1800s, and unrestricted removal of logs by firewood cutters in the lower reaches has inhibited re-establishment of large woody debris in this area. Gravel extraction occurs at numerous locations below the Mad River Hatchery and has been an important commercial activity for some time, removing approximately 15.5 million cubic yards of gravel between 1952 and 1992. The Humboldt Bay Municipal Water District, which provides water to communities and industry around Humboldt Bay, pumps its water from wells in the lower Mad, just above the Highway 299 bridge. This history of development has resulted in channelization of the lower 10 miles of the Mad River.

#### **4.4.8.7 Salmonid Population Estimates**

Cañon Creek is currently the only stream routinely monitored in the Mad River HPA. Spawner escapement survey frequency, spacing, and duration have helped to make it one of the most well monitored creeks for adult escapement.

##### **4.4.8.7.1 Summer Juvenile Population Estimates**

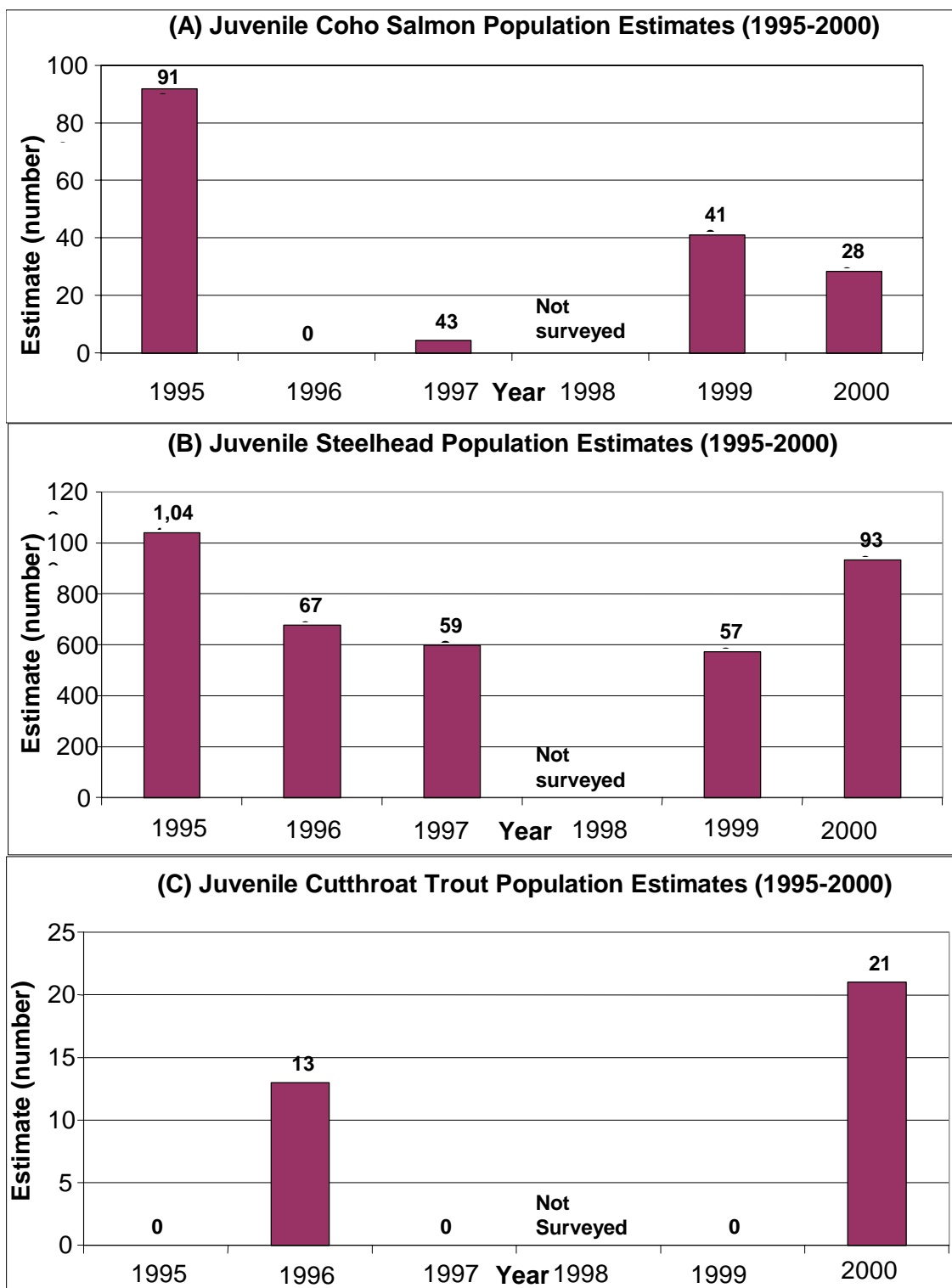
A summary of 1995 through 2000 juvenile coho salmon, steelhead, and cutthroat trout summer population estimates for Cañon Creek are shown in Figure 4-36 (A-C) (see Appendix C7 for details).

As seen in Figure 4-36 (A) the number of coho salmon in Cañon Creek ranged from 43 to 919 juveniles for the four years when surveys were conducted. No juvenile population estimates were made for 1996 and 1998. Steelhead estimates for the five years for which estimates were made ranged from nearly 600 to over 1,000 juveniles (Figure 4-36 [B]). No estimates were made for year 1998. Juvenile cutthroat trout populations in Cañon Creek for the four years estimates were made ranged from 0 to 21 juveniles (Figure 4-36 [C]). No cutthroat trout juvenile population estimates were made in 1998.

In summary, population estimates indicate that juvenile coho populations have been very variable in Cañon Creek over the period of surveys. Juvenile steelhead populations are somewhat stable between years and appear to be robust in Cañon Creek. Summer population estimates for cutthroat indicated there are small numbers of juveniles of these species, and some variability from year to year in the stream surveyed.

##### **4.4.8.7.2 Adult Spawner Surveys**

Spawning surveys have been conducted annually on Cañon Creek from 1995 through 2000 (see Appendix C9 for details). During these spawner surveys, chinook salmon were the most common species observed, followed by steelhead and coho salmon, respectively.



**Figure 4-36. Summary of the juvenile population estimates for coho salmon, steelhead, and coastal cutthroat trout in Cañon Creek in the Mad River HPA (1995-2000).**

The results to date indicate that large numbers of chinook adults, redds, and carcasses have been observed in Cañon Creeks during all years surveyed. Many fewer live steelhead, carcasses, and redds have been observed and only during the 1997-1998 and 1999-2000 surveys. Very few coho adults, redds, and carcasses have been observed in any years except during 1998-1999 when no coho were observed in Cañon Creek.

#### 4.4.8.7.3 Mad River Summer Steelhead Population Survey

Since 1982 the U.S. Forest Service has surveyed 2 Mad River Index reaches that are upstream of the Green Diamond property from Ruth Dam downstream to Deer Creek. Comprehensive dive counts of adult summer steelhead in the Mad River have been conducted since 1994. The comprehensive surveys were initiated in response to observed declines in summer steelhead counts within index reaches surveyed annually by U.S. Forest Service personnel upstream of Green Diamond's Mad River property.

Green Diamond and CDFG personnel conduct annual dive surveys extending from Deer Creek to the CDFG's Mad River Hatchery (see Appendix C10 for details). This segment includes eight reaches and a total of approximately 36 miles of the mainstem Mad River. CDFG annually surveys the Mad River downstream of the Mad River Hatchery to Kadle Hole near the Highway 299 bridge. A summary of the results of the dive surveys for years 1994 through 2000 are shown in Figure 4-37.

As shown in Figure 4-37, the total number of adult and half-pounder steelhead in the Mad River during these surveys seemed to peak in the 1995 survey at 550. This peak maybe a result of factors such as different water-year types; variations in habitat conditions and in spawning, and rearing success; and changes in oceanic and climatic conditions prior to and since 1995.

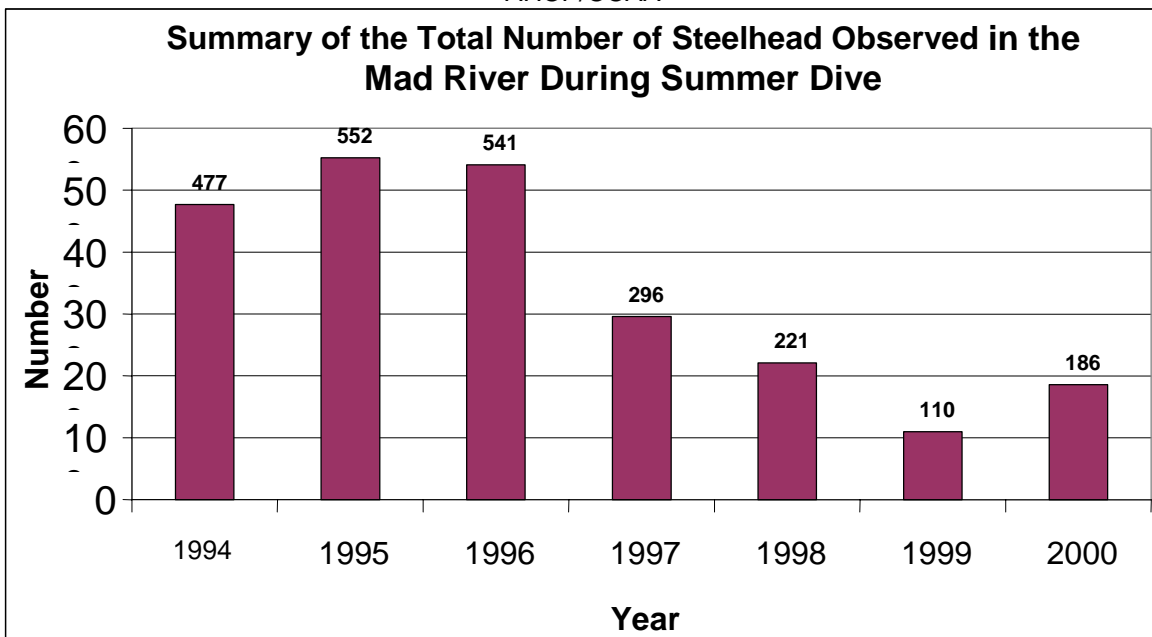


Figure 4-37. Summary of the Mad River summer steelhead population surveys (1994-2000).

#### 4.4.8.8 Covered Species Occurrence and Status

Presence/absence of the Covered Species in the Mad River HPA is presented by drainage in Table 4-11, and the recorded distribution of the species is displayed in **Figure 4-38**.

##### 4.4.8.8.1 Chinook Salmon

The Mad River HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA as of September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the decision to list this ESU as threatened (64 FR 50405). Nehlsen et al. (1991) identified Mad River fall-run chinook as at moderate risk of extinction. Abundance trends have declined in the Mad River Basin over the long term but show signs of increasing in recent years (64 FR 50405).

**Table 4-11. Covered Species distribution in the Mad River HPA.**

<b>Watersheds and Sub-basins</b>	<b>Chinook</b>	<b>Coho</b>	<b>Steelhead and RRT*</b>	<b>Coastal Cutthroat</b>	<b>Tailed Frog</b>	<b>Torrent Salamander</b>
Strawberry Creek	A	1,2	2	2,3	A	A
Mad River	2,3	1,2,3	2,3	2,3	3	3
Widow White Creek	2	2	2,3	2,3	A	A
Mill Creek	2	2,3	2,3	2	A	A
Essex Gulch	A	A	A	3	U	U
Lindsay Creek	2	1,2,3	2,3	2,3	U	3
Grassy Creek	3	1,2	2	2	U	U
Squaw Creek	2,3	1,2	2	2	U	U
Timmons Creek	A	A	A	3	U	U
Mather Creek	P	1,2,3	2,3	2,3	A	A
Noisy Creek	U	1,2	2	U	U	U
Mill Creek	2	1,2	2	P	U	U
Hall Creek	2	1	2	P	U	U
Powers Creek	P	1,2	2,3	P	P	P
Quarry Creek	A	1	2	A	P	P
Puter Creek	A	A	2	A	P	P
Boundary Creek	A	A	3	A	3	3
Black Dog Creek	A	A	3	A	3	3
Dry Creek	3	1,2	2,3	A	3	3
Cañon Creek	2,3	1,2,3	2,3	3	3	3
Simpson Creek	A	A	2,3	A	P	P
Devil Creek	A	A	2,3	A	3	3
No Name Creek	U	U	U	U	P	3
Maple Creek	2	1,2	2,3	U	3	3
Davis Creek	U	U	2	U	P	P
Bear Creek	U	U	U	U	U	U
Boulder Creek	2	1, 2	2,3	A	3	3
Little Boulder Creek	A	A	U	A	P	P
Goodman Prairie Creek	A	A	U	A	P	3
Graham Creek	A	A	U	A	3	3
Madrone Creek	A	A	U	A	P	P
Wilson Creek	A	A	2	A	P	P
<b>Codes</b>  U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT= resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records						

#### 4.4.8.8.2

### Coho Salmon

The Mad River HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA as of May 1997 (62 FR 24588). Populations of coho are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

Mad River Hatchery coho stocks are not considered part of the Southern Oregon/Northern California Coasts ESU, as they have included transplants from outside the area (Weitkamp et al. 1995). As shown in Table 4-11, coho are fairly well distributed within this HPA, but almost no information on total coho abundance or proportion of naturally spawning hatchery fish is available.

#### 4.4.8.8.3 Steelhead and Resident Rainbow Trout

The Mad River HPA includes the Northern California Steelhead DPS, which was listed as threatened on June 7, 2000 (65 FR 36074). Steelhead abundance data are limited for this DPS. Available data indicate that winter-run populations declined significantly prior to 1970 and that populations have remained at depressed levels with no clear trends since then (Busby et al. 1996).

Summer steelhead abundance in the Mad River has been monitored from 1982 to the present, revealing unexpectedly high abundance in 1994-1996, with a sharp downward trend in more recent years (see Appendix C10 for details). Information on winter run steelhead is lacking. The genetic effect of the Mad River Hatchery steelhead releases on the native winter steelhead population is a source of concern within this HPA (Busby et al. 1996).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.8.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Coastal cutthroat trout are only occasionally observed in the mainstem Mad River but are abundant in some lower Mad River tributaries, including Lindsay, Widow White, and Mill creeks (Gerstung 1997). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### 4.4.8.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs 12 streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Mad River HPA, 7 of 12 (58.3%) sampled streams

had tailed frogs. In addition, populations of tailed frogs were confirmed in 17 other streams in the HPA either through other types of amphibian surveys or incidental observations.

Given the moderate rate of occurrence and somewhat limited number of streams known to support the species, tailed frog streams in the Mad River HPA appear to be in moderate condition. However, other tailed frog studies (e.g. headwaters monitoring and life history studies) in this HPA indicate that, depending on the localized geology, some streams provide excellent habitat for tailed frogs while others completely lack habitat for the species.

#### **4.4.8.6 Southern Torrent Salamander**

Green Diamond conducted presence/absence surveys for southern torrent salamanders 12 streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Mad River HPA, 8 of 12 (66.7%) sampled streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 54 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Given the moderate rate of occurrence, torrent salamander streams in the Mad River HPA appear to be in relatively poor condition. However, other southern torrent salamander studies (e.g., headwaters monitoring and life history studies) and the relatively large number of streams known to support the species in this HPA indicate that, depending on the localized geology, some streams provide excellent habitat for torrent salamanders while others completely lack habitat for the species.

#### **4.4.8.9 Assessment Summary**

Due to the coastal influence and high canopy closure on most streams, water temperatures are generally good in streams in the Original Assessed Ownership in the Mad River HPA. The primary exceptions are the lower reaches of Cañon Creek, which typically have very low flows in late summer. The majority of the canopy in the lower reaches of this stream is composed of alder and willow, and much of this was destroyed by high water during the winter of 1996/97. High incident solar radiation coupled with minimal flows resulted in high localized water temperatures during the late 90s in Cañon Creek.

The coastal portion of the HPA is largely composed of young marine sediments that are generally weakly consolidated and highly erodible. As a result, streams in this area have high levels of fine sediments. Although only three Class I watercourses on the Original Assessed Ownership in the Mad River HPA were assessed, the amount and quality of pool habitat is generally consistent with other assessed streams in Original Assessed Ownership. This habitat is probably less than optimum for salmonids, due primarily to a general deficiency in the larger classes of LWD resulting from past timber management and active removal programs.

The salmonid Covered Species are relatively common in the coastal streams of the Original Assessed Ownership in this HPA, while the amphibian Covered Species are more common in streams in the middle portions of this HPA. The primary explanation for

this pattern is related to geology. The unconsolidated geology of the coastal streams creates substrates that are completely unsuitable for the covered amphibian species. The streams in the middle portions are located in more consolidated geologic parent material, which produces the necessary coarse stream substrates. However, most of these streams are too steep to provide habitat for salmonids. Cañon Creek is the only substantial sub-basin that has both low gradient reaches for salmonids and the appropriate geology for the amphibians. The streams on the Original Assessed Ownership in the upper portions of this HPA have a more interior climate and lower canopy closure that can result in higher water temperatures. In addition, the upper portion of this HPA is pervasively underlain by deep-seated landslides and earthflows associated with soft Franciscan Complex bedrock. Although there is consolidated geologic parent material that contribute coarse substrate material to streams, the extensive fine sediment inputs from prairie soils earthflows in this area result in streams that are heavily imbedded with fine sediments. In addition to the generally poor substrates in most streams, most of the tributaries off the mainstem Mad River in the upper portions of this HPA are sufficiently high gradient that no potential fish habitat exists.

It is not likely that water temperature limits populations of any Covered Species in streams on the Original Assessed Ownership, although temperatures may have had a temporary impact in the lower reaches of Cañon Creek. Spawning habitat may be limiting in some of the coastal streams on the Original Assessed Ownership in this HPA, including the Lindsay Creek sub-basin, but little data have been collected in these streams to quantify habitat conditions. Despite this, the limited biological data indicate that Lindsay Creek has high numbers of juvenile salmonids. Tannic waters and complex habitat preclude application of standard field protocols to allow quantification of their numbers. In Cañon Creek, stored sediment from past management activities and the need for greater amounts of LWD probably limits the amount and quality of summer and winter rearing habitat for the covered salmonid species. Debris flows triggered from roads have been documented to significantly impact several amphibian populations.

Therefore, the primary management emphasis for the Plan Area within the Mad River HPA should be to accelerate the recruitment of future LWD delivery to Class I watercourses and address road-related sediment inputs.

#### **4.4.9 North Fork Mad River HPA**

##### **4.4.9.1 HPA Type, Size, and Group**

The North Fork Mad River HPA is a hydrologic unit as defined in this Plan and is part of the Korbel HPA Group. It includes approximately 31,416 acres.

##### **4.4.9.2 Eligible Plan Area**

The Eligible Plan Area in the North Fork Mad River HPA includes approximately 31,416 acres: 28,209 acres of Initial Plan Area and 3,207 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

#### **4.4.9.3 Geology**

The North Fork Mad River HPA is within the Coast Ranges Province (see **Figure 4-1**). Bedrock within the HPA is composed mostly of Central Belt Franciscan Complex with Quaternary – Tertiary Overlap deposits in the southwest section, juxtaposed by the complex northwest-trending, north-east dipping Mad River thrust fault system.

From east to west, the Franciscan bedrock within the area is Redwood Creek Schist along the east margin, Sandstone and Melange of Snow Camp Mountain and Undifferentiated Franciscan Complex rocks (also identified as Broken Formation rock on the west side of the Undifferentiated Franciscan (by McLaughlin) and Quaternary – Tertiary Overlap deposits. The northwest-trending, northeast-dipping Bald Mountain fault separates rocks of the Redwood Creek Schist and the Snow Camp Mountain unit in the east portion of the watershed.

The topography of the region is relatively steep and mountainous, similar to the rest of the Mad River Watershed. Similar to the rest of the Mad River hydrographic region, both shallow and deep-seated landslides exist throughout this HPA. Deep-seated rotational/translational landslides and earthflows are common in the Franciscan mélangé. Younger bedrock in the area is generally described as poorly consolidated, uncemented, interbedded sands, silts, clays and gravels. These materials are extremely erodible, and they are very susceptible to slumping and rotational slide movement.

#### **4.4.9.4 Climate**

The average daily air temperature in the North Fork Mad River Hydrologic Unit ranges from a high of 62°F during August to a low of 40°F in January. The average annual precipitation in this Hydrologic Unit ranges from 60 to 80 inches, with rainfall increasing inland. Most precipitation occurs between October and May. The five largest instantaneous peak discharges recorded at the USGS gauging station along the Mad River near Arcata (Station No 11481000) occurred during water years 1953, 1956, 1965, 1972, and 1986.

#### **4.4.9.5 Vegetation**

The North Fork Mad River is one of the most heavily forested HPAs, with all but an estimated 300 acres of natural grassland in forest cover at the time of white settlement. The only changes in land use that have occurred since that time include Green Diamond's mill complex at Korbel, the right-of-way for State Highway 299 that bisects the HPA, and a portion of the town of Blue Lake.

The mouth of the North Fork is located approximately 8 miles from the coast, and its eastern-most edge is roughly 13 miles inland. Its elevation ranges from 200 feet to 3400 feet. Redwood occurs to around 2200 feet in elevation throughout most of the Unit. A notable exception, undoubtedly due to soil characteristics, is a band of Douglas-fir dominated forest on both sides of the drainage that begins just above Korbel and persists to a line across the watershed approximately where Highway 299 crosses the North Fork. This area contains only occasional individual redwoods, regardless of elevation, and has a higher proportion of western red cedar and western hemlock on lower slopes and in riparian areas than would normally be expected this far inland.

Higher elevations along the eastern and southern boundary of this HPA are forested entirely with Douglas-fir and tanoak, either in relatively pure stands or associated in mixed stands. Red alder occurs in riparian zones throughout the HPA, except at the highest elevations.

#### **4.4.9.6 Current Habitat Conditions**

##### **4.4.9.6.1 Water Temperature**

Water temperature monitoring in streams on the Original Assessed Ownership the North Fork Mad River HPA began in 1994 and is ongoing today (see Appendix C5 for details). Figure 4-39 displays the 7DMAVG (7 day maximum moving average) water temperatures for each site in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds in this Plan. From 1994-2001, 39 summer temperature profiles were recorded at 18 sites in 15 Class I watercourses in the HPA. An additional 13 summer temperature profiles were recorded at 6 headwater sites within 3 Class II watercourses. The results for the monitoring period (1994-2000) indicate that none of the Class I or Class II monitoring sites exceeded the yellow or red light threshold.

##### **4.4.9.6.2 Channel and Habitat Typing**

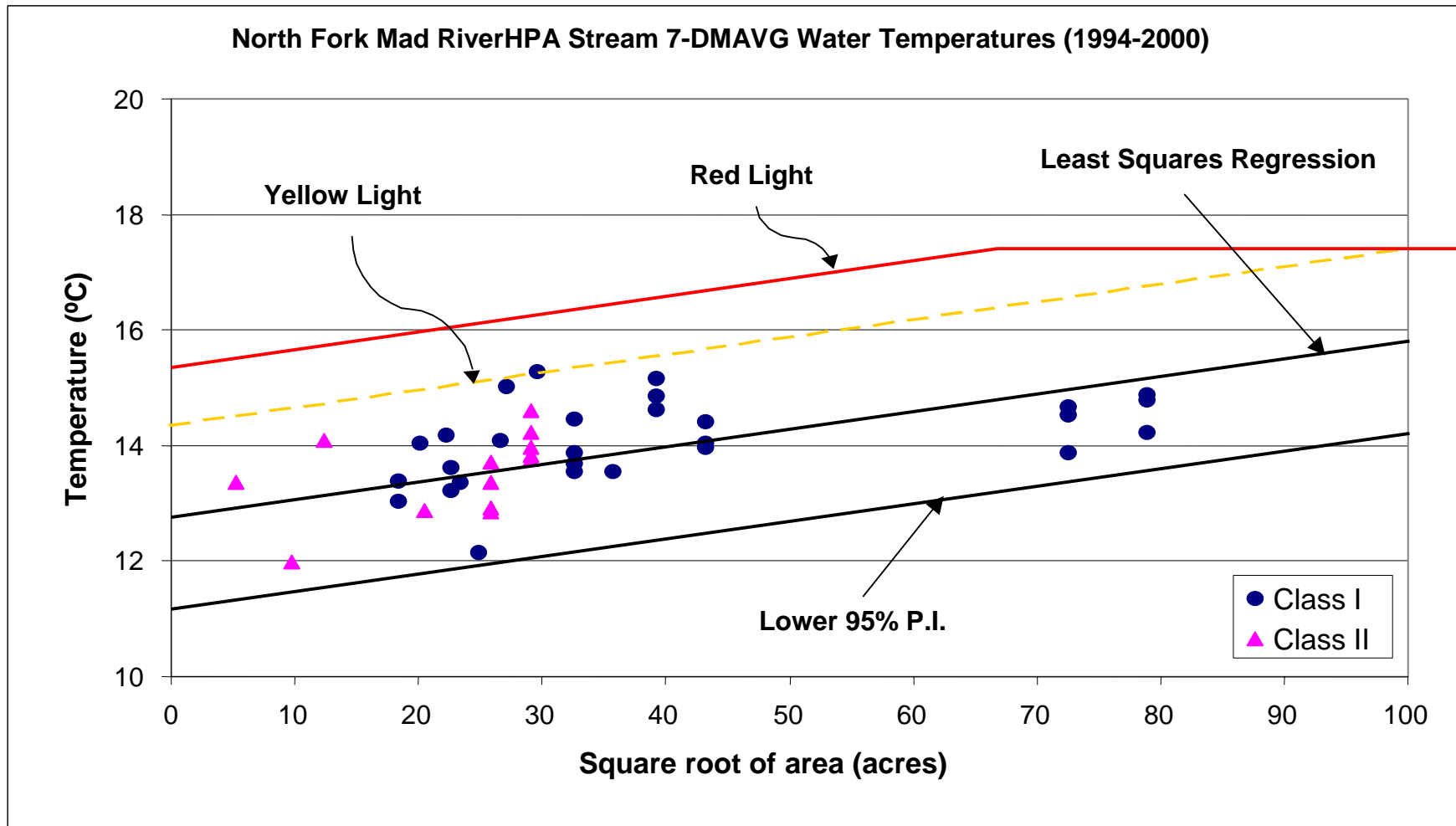
Green Diamond assessed two streams in 1994-5 within the North Fork Mad River HPA: (see Appendix C1 for details and Table C1-7 for summary of data collected):

<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
North Fork Mad River	11,273 acres	1.4%
Long Prairie Creek	4,592 acres	2.6%

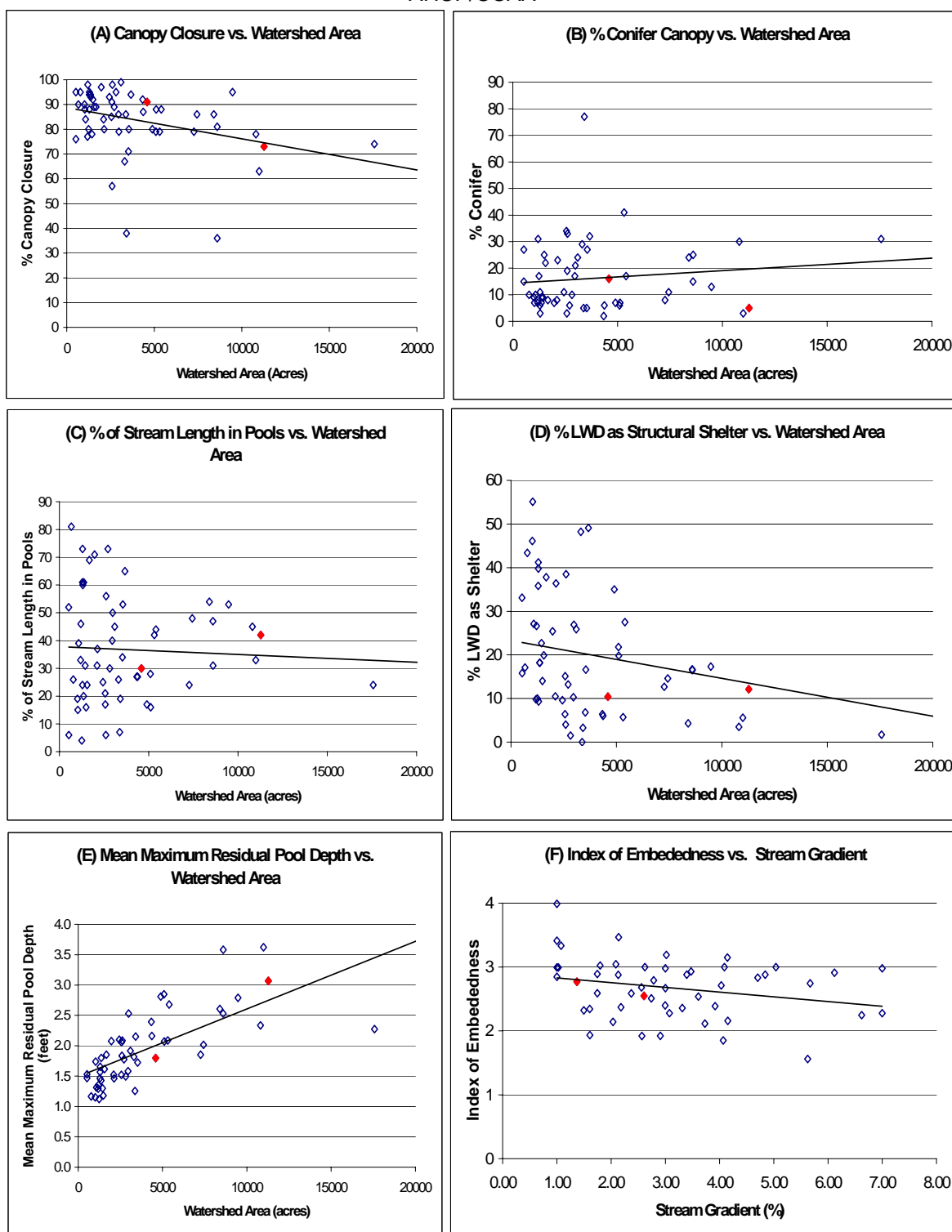
The results of the assessments are summarized below and depicted in Figure 4-40 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

The results for the two assessed streams indicate the following:

- Percentage canopy closure for the two streams (73-91%) is somewhat typical for other assessed streams of similar watershed area. The percentage of conifer canopy for North Fork Mad River is relatively low (5%) (Figure 4-40 [A and B]).
- Percentage of stream length in pools for the two streams (30-42%) are comparable to other assessed streams of similar watershed area (Figure 4-40 [C]).
- The percentage of LWD as structural cover in pools for the two streams (10-12%) is somewhat low, and the LWD in Long Prairie Creek is somewhat lower than in other assessed streams of comparable watershed area (Figure 4-40 [D]).



**Figure 4-39.** 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the North Fork Mad River HPA monitored between 1994 and 2000.



**Figure 4-40.** Channel and habitat types in two streams assessed in the North Fork Mad River HPA. (Solid diamonds are assessed streams in North Fork Mad River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

- Figures 4-40 [E] and [F] depict the average residual pool depths and the substrate embeddedness for the two streams. The values for Long Prairie Creek and North Fork Mad River are generally typical for other assessed streams of similar watershed area. The exception is that the average residual pool depth in the North Fork Mad River (3.1 feet) is the third deepest of any assessed stream on the Original Assessed Ownership.

In summary, these results suggest that the habitat within the two assessed streams of the North Fork Mad River HPA is, in many instances, similar to other assessed streams of similar watershed area. There are, however, some habitat differences.

#### 4.4.9.6.3 LWD Inventory

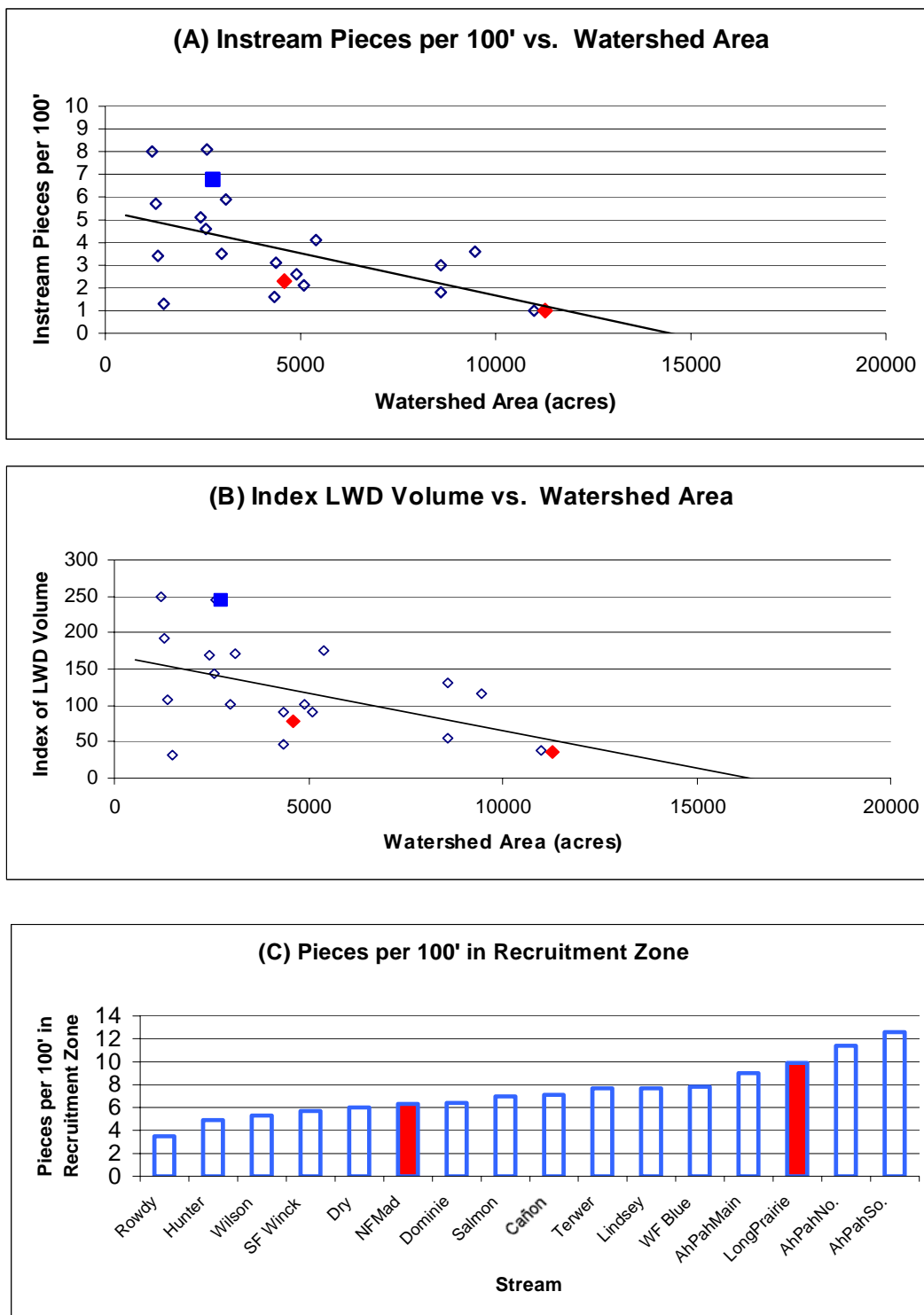
LWD survey/inventories were conducted in 1994 and 1995 in two streams within the North Fork Mad River HPA: North Fork Mad River and Long Prairie Creek (see Appendix C2 for details). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD. The results of these investigations are summarized below and presented in Figure 4-41 (A, B and C).

- As shown in Figure 4-41 (A), the average number of in-stream LWD pieces per 100 feet of channel for North Fork Mad River and Long Prairie Creek (1.0 to 2.3) were some of the lowest found in surveys on the Original Assessed Ownership. This average is similar to that for other assessed streams of comparable watershed area and approximately one-third of the average for Prairie Creek.
- LWD volume indices for the two streams are shown in Figure 4-41 (B). In general, the indices for the two streams are somewhat lower than those for other streams with similar watershed areas and are 15% to 32% of that for Prairie Creek.
- The average number of LWD pieces per 100 feet of channel in the riparian recruitment zone is relatively high for Long Prairie (9.9 pieces) and low for North Fork Mad River (6.3 pieces) (Figure 4-41 [C]).

In summary, the two assessed streams in this HPA have some of the lowest LWD piece counts and volume indices for their watershed size of all assessed streams on the Original Assessed Ownership.

#### 4.4.9.6.4 Long Term Channel Monitoring

Using the information gathered in channel monitoring pilot studies that began in 1993, a revised methodology was developed and first implemented in Canyon Creek beginning in 1996. In 1997 additional channel monitoring data was obtained from Canyon Creek. These surveys have continued with scheduled re-surveys every two years or after a five-year flood event. Data collected at the monitoring sites since 1998 are scheduled for analysis in 2003. Each monitoring reach should have at least 3 years of data prior to the first analysis and be updated biennially to coincide with the biennial report to the Services that will be prepared under this Plan. The monitoring objectives, methods and results to date for channel monitoring activities in the North Fork Mad River HPA are presented in Appendix C3. No conclusions can be drawn at this point.



**Figure 4-41.** LWD survey results for two streams assessed in the North Fork Mad River HPA. (Solid diamonds are assessed streams in North Fork Mad River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)

#### 4.4.9.7 Salmonid Population Estimates

Chinook are the most frequently recorded species in North Fork Mad River, followed by steelhead and coho, respectively. Chinook salmon escapement appears robust, with only one to two surveys each season recording large adult returns. Steelhead are fairly common in early winter surveys, but the majority of survey dates in late December are probably too early to record significant numbers. Coho are infrequently observed; however, this is likely a factor of water visibility and survey timing. Sullivan Gulch has been surveyed since 1996. Limited numbers of chinook, coho and steelhead have been observed. Chinook are the most frequently recorded salmonid, but steelhead may also make up a significant component of the survey if conducted later in the year. Based on juvenile population estimates, however, coho also make up a significant portion of the adult run, although they are rarely observed during spawning surveys.

##### 4.4.9.7.1 Summer Juvenile Population Estimates

The 1999 and 2000 juvenile coho salmon and steelhead summer population estimates for Sullivan Gulch are shown in Figure 4-42. The number of coho salmon in Sullivan Gulch ranged from approximately 50 to nearly 800 juveniles for the two years surveyed. Steelhead estimates for the two years were very low and ranged from less than 20 to less than 60 juveniles. No coastal cutthroat trout were observed in Sullivan Gulch during population surveys. In summary, population estimates indicate that juvenile coho summer populations were variable in Sullivan Gulch between these two surveys, with good numbers found in 1999 and very low numbers seen in 2000. Juvenile steelhead summer populations were found to be very low in Sullivan Gulch during both years surveyed.

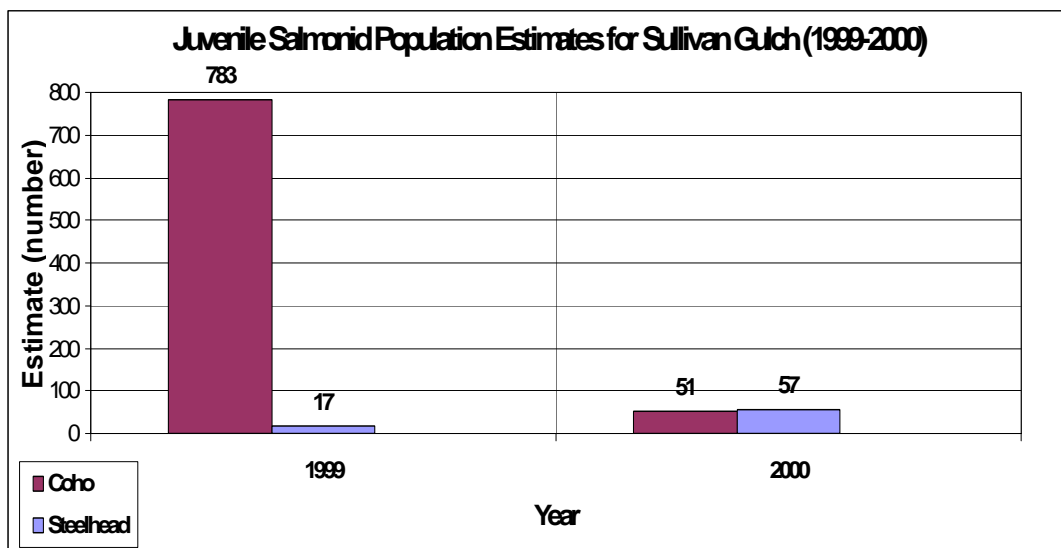


Figure 4-42. Summary of summer juvenile salmonid population estimates conducted in Sullivan Gulch in the North Fork Mad River HPA in 1999 and 2000.

#### **4.4.9.7.2 Adult Spawner Escapement Surveys**

Annual spawner surveys have been conducted on two streams (North Fork Mad River and Sullivan Gulch) in this HPA since 1996. The results to date indicate that large numbers of chinook adults (range 42 to 214), redds (range 15 to 213), and carcasses (range 21 to 293) have been observed in North Fork Mad River during the years surveyed. A few live steelhead (range 0 to 3) and redds (range 0 to 2) have been observed only during the 1996-7, 1998-1999, and 1999-2000 surveys. Very few coho adults (3) were observed in 1997-1998 in North Fork Mad River.

Adult spawner surveys for Sullivan Gulch also indicate spawning by chinook salmon although at lower numbers than the North Fork Mad River. Live chinook (range 12 to 220), redds (range 7 to 108), and carcasses (range 0-102) have been observed in all years except 1997-1998. Very few steelhead and coho salmon have been observed in Sullivan Gulch in these surveys, although a number of unidentified redds and a few unidentified carcasses are observed each year. Some of the unidentified redds and carcasses may have been steelhead or coho salmon.

#### **4.4.9.8 Occurrence and Status of Covered Species**

Presence/absence of the Covered Species in the North Fork Mad River HPA is presented by drainage in Table 4-12, and the recorded distribution of the species is displayed in **Figure 4-43**.

##### **4.4.9.8.1 Chinook Salmon**

The North Fork Mad River HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA as of September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the decision to list this ESU as threatened (64 FR 50405).

Nehlsen et al. (1991) identified Mad River fall-run chinook as at moderate risk of extinction. Abundance trends have declined in the Mad River Basin as a whole over the long term but show signs of increasing in recent years (64 FR 50405). A barrier to chinook and coho salmon migration occurs at roughly RM 4 in the North Fork Mad River. This barrier severely restricts the spawning and rearing area available to chinook in this HPA. Spawner surveys in this HPA indicate highly variable chinook returns in the North Fork Mad and its tributaries below the barrier (see Appendix C9.).

**Table 4-12. Covered Species distribution in North Fork Mad River HPA.**

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Mad River	2,3	1,2,3	2,3	2,3	3	3
North Fork Mad River	2,3	1,2,3	2,3	2,3	3	3
Mill Creek	A	A	3	3	A	A
Sullivan Gulch	2,3	1,2,3	2,3	U	P	3
Hatchery Creek	3	3	3	U	3	P
Jiggs Creek	A	A	A	A	3	3
Bald Mt. Creek	A	A	3	U	3	3
Pollock Creek	A	A	2,3	U	3	3
Long Prairie Creek	2	1,2	2,3	U	3	3
Pine Creek	A	A	2,3	U	3	P
Gossinta Creek	A	A	2,3	A	P	3
Denman Creek	A	A	3	A	3	3
Mule Creek	A	A	2	2,3	3	3
Jackson Creek	A	A	2	A	3	P
Krueger Creek	A	A	3	A	P	P
Railroad Creek	A	A	2	A	3	P
Canyon Creek	2	A	2,3	U	3	3
East Fork N. F. Mad River	A	A	2,3	2,3	3	P
<b>Codes</b> U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT= resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records						

#### 4.4.9.8.2 Coho Salmon

Populations are depressed throughout the Southern Oregon/Northern California Coho ESU, which encompasses the North Fork Mad River HPA. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp *et al.*, 1995). This ESU has been listed as threatened under the ESA as of May 1997 (62 FR 24588).

A barrier to chinook and coho salmon migration occurs at roughly RM 4 in the main stem North Fork Mad River, severely limiting the spawning and rearing area available to coho in this HPA. Spawner surveys and juvenile population estimates below the barrier indicate low numbers of coho returns in this HPA (Appendix C7 and C9).

#### 4.4.9.8.3 Steelhead and Resident Rainbow Trout

The North Fork Mad River HPA includes the Northern California Steelhead DPS, which was listed as threatened effective August 7, 2000 (65 FR 36074). Steelhead abundance data are limited for this DPS, but available data indicate that winter-run populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby *et al.* 1996).

Information on steelhead within this HPA is limited to the presence/absence information shown in Table 4-12 above. Steelhead are able to pass the barrier mentioned above for chinook and coho and therefore can utilize more of the North Fork drainage than other anadromous salmonids. NMFS found that for the seven populations of steelhead within this ESU only the small summer steelhead population within the Mad River, which has had large supplemental production from hatchery sources and Prairie Creek winter steelhead have shown recent trends of increasing abundance (65 FR 36082). The genetic effects of the Mad River Hatchery steelhead releases on the native winter steelhead population are a source of concern in the Mad River Basin (Busby et al. 1996). The extent of hatchery fish spawning naturally in the North Fork Mad River HPA is unknown.

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.9.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Little is known about coastal cutthroat trout in the North Fork Mad River HPA. The barrier to anadromy on the main stem North Fork Mad implies that coastal cutthroat trout in most of this HPA (above the barrier) are resident fish. When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### 4.4.9.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in seven streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the North Fork Mad River HPA, 6 of 7 (85.7%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 28 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Given this high rate of occurrence and large number of streams known to support the species, tailed frogs streams in the North Fork Mad River HPA seem to be in excellent condition.

#### 4.4.9.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in seven streams in this HPA. The studies were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the North Fork Mad River HPA, 6 of 7 (85.7%) sampled streams had southern torrent salamanders. In addition, populations of southern torrent salamanders were confirmed in 80 other

streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Given this high rate of occurrence and large number of streams known to support the species, torrent salamanders streams in the North Fork Mad River HPA seem to be in excellent condition.

#### **4.4.9.9    *Assessment Summary***

Due to the coastal influence and high canopy closure on most streams, water temperatures are generally good throughout streams on the Original Assessed Ownership in the North Fork Mad River HPA. The HPA has a mixed geologic composition, characteristic of the Franciscan Complex, but much of it is relatively stable compared with many of the other HPAs, and the parent material is relatively competent (consolidated) so that substrates are relatively coarse in most streams. Although only two Class I watercourses on the Original Assessed Ownership were assessed, the amount of pool habitat was generally consistent with assessed streams throughout the entire Original Assessed Ownership, but the quantity of LWD tended to be low. As a result, the amount of salmonid habitat is probably adequate for salmonids, but it is probably lacking in quality for both summer and winter rearing habitat.

Outside the lower mainstem of the North Fork Mad River and a few of the lower tributaries, the salmonid Covered Species are not widespread on the Original Assessed Ownership in this HPA. This is due to a natural barrier (falls/cascade) low in the system that prevents all but the most tenacious of steelhead from reaching the upper sub-basin. In addition, many of tributaries have steep gradients that would limit the amount of salmonid habitat even if the fish could get past the mainstem barrier. In contrast, the amphibian Covered Species are particularly abundant in all but a few streams on the Original Assessed Ownership in this HPA due to generally favorable geologic conditions.

Water temperatures are not likely to be limiting and may even be ideal for the Covered Species in streams on the Original Assessed Ownership, except for the lowest reaches of the mainstem where the water goes subsurface and forms isolated pools in late summer. The limited access for fish throughout the majority of the North Fork Mad River HPA appears to result in an under-utilization of the habitat, so that even if habitat quality were to improve, it would not likely result in a significant increase in salmonid numbers. A solution to the mainstem barrier for chinook and coho salmon would open up about 15 miles of habitat. This would probably result in dramatic increases in the productivity of this system. Sediment inputs from roads have the potential to negatively impact the amphibian Covered Species.

Except for addressing road-related sediment inputs, there would be little benefit of other conservation efforts in the Plan Area of the North Fork Mad River HPA without a permanent solution to the mainstem barrier.

#### **4.4.10    *Humboldt Bay HPA***

##### **4.4.10.1    *HPA Type, Size, and Group***

The Humboldt Bay HPA is a hydrographic area as defined in this Plan and is part of the Humboldt Bay HPA Group. It includes approximately 138,719 acres.

#### **4.4.10.2 Eligible Plan Area**

The Eligible Plan Area in the Humboldt Bay HPA includes approximately 38,870 acres: 17,484 acres of Initial Plan Area and 21,386 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

#### **4.4.10.3 Geology**

The Humboldt Bay HPA is within the Coast Ranges Province (see **Figure 4-1**). Quaternary–Tertiary overlap deposits and Quaternary age alluvium occur in the HPA, with Yager Terrane near the southern boundary and Central Belt Franciscan Complex bedrock under the eastern quarter of the area.

The bedrock in the HPA includes both the Quaternary – Tertiary overlap deposits and the Central Belt Franciscan Mélange. The overlap deposits within the area include the Wildcat Group, which are composed of moderately consolidated, poorly cemented, weak siltstone, claystone and fine sandstone, as well as the Falor Formation. These strata were deposited on an erosional surface of Franciscan and Yager Formation rocks, and they have been subsequently eroded, faulted, folded and partly covered with younger sedimentary rocks. The Central Belt Franciscan Mélange is described as a weak, pervasively sheared claystone matrix, which encloses various-sized blocks of hard sandstone, greenstone, metavolcanic rock, serpentinite, chert and schist. Some of the different lithologic blocks in the melange are large enough to be mapped separately at a large enough scale.

The Fickle Hill Fault (part of the Mad River Fault zone), the Freshwater Fault, and the Little Salmon Fault are the three main faults within the Humboldt Bay region. They have north-northwest to northwest alignments and northeast dips. The Little Salmon Fault and the Table Bluff Anticline define the topographic high at the southwest boundary of the hydrographic region and the Freshwater Fault separates the Central Belt Franciscan Complex from the younger rock formations in the central portion of the region.

Topography within the Quaternary–Tertiary overlap deposits is well dissected and of relatively low relief. The Wildcat Group and younger rocks in most of the Humboldt Bay hydrographic region are highly erodible and fragments of the rock readily break-down in the streambeds to sand, silt and clay. Published landslide maps indicate that both shallow and deep-seated landslides exist within this HPA.

#### **4.4.10.4 Climate**

The watersheds that drain into Humboldt Bay are influenced by the coastal weather patterns of northern California. Typically, the majority of precipitation falls as rain between November and April with snowfall occurring sporadically at higher elevations. Eureka receives about 35 inches to 40 inches of rain annually, whereas inland areas of the basin may receive 60" or more per year. During the summer the climate is moderated by coastal fog which reduces solar radiation and contributes moisture by fog drip.

#### **4.4.10.5 Vegetation**

The Humboldt Bay HPA encompasses Humboldt Bay and the four major streams that drain into it, which, from north to south, are Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek. Its eastern boundary is only 14 miles inland and elevation does not exceed 2800 feet. The entire HPA is within the summer fog zone, and all vegetative types reflect a strong coastal influence. Natural grasslands that typify the inland reaches of most HPAs exist as only a few small prairies at the extreme eastern margin of the HPA on or near the divide into the Mad River and Eel River drainages.

This HPA is the most heavily populated HPA. Residential, commercial, and agricultural development have eliminated or drastically altered most of the natural vegetative communities on the coastal plain and have significantly impacted most estuarine habitats. Although hillsides adjacent to the coastal plain still retain much of the indigenous redwood/Douglas-fir/red alder type, residential development permeates all but the steepest slopes surrounding the cities of Arcata and Eureka. Outside of developed areas, redwood/Douglas-fir forests dominate, and persist to the eastern boundaries of the HPA. Spruce is common near the coast, and minor amounts of grand fir, western red cedar, and western hemlock occur on lower slopes and in riparian zones. Red alder dominates many riparian zones, and tanoak is the most common mid to upper slope hardwood.

#### **4.4.10.6 Current Habitat Conditions**

##### **4.4.10.6.1 Water Temperature**

Water temperature monitoring in streams on the Original Assessed Ownership in the Humboldt Bay HPA began in 1994 and is ongoing today (see Appendix C5). From 1994-2000, 35 summer temperature profiles were recorded at 13 sites within 9 Class I watercourses in the HPA. No Class II temperature sites have been monitored to date. Figure 4-44 displays the 7DMAVG water temperatures for each site in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for the monitoring period (1994-2000) indicate that one Class I site (Salmon Creek) exceeded the red light threshold in 1997 and 1998.

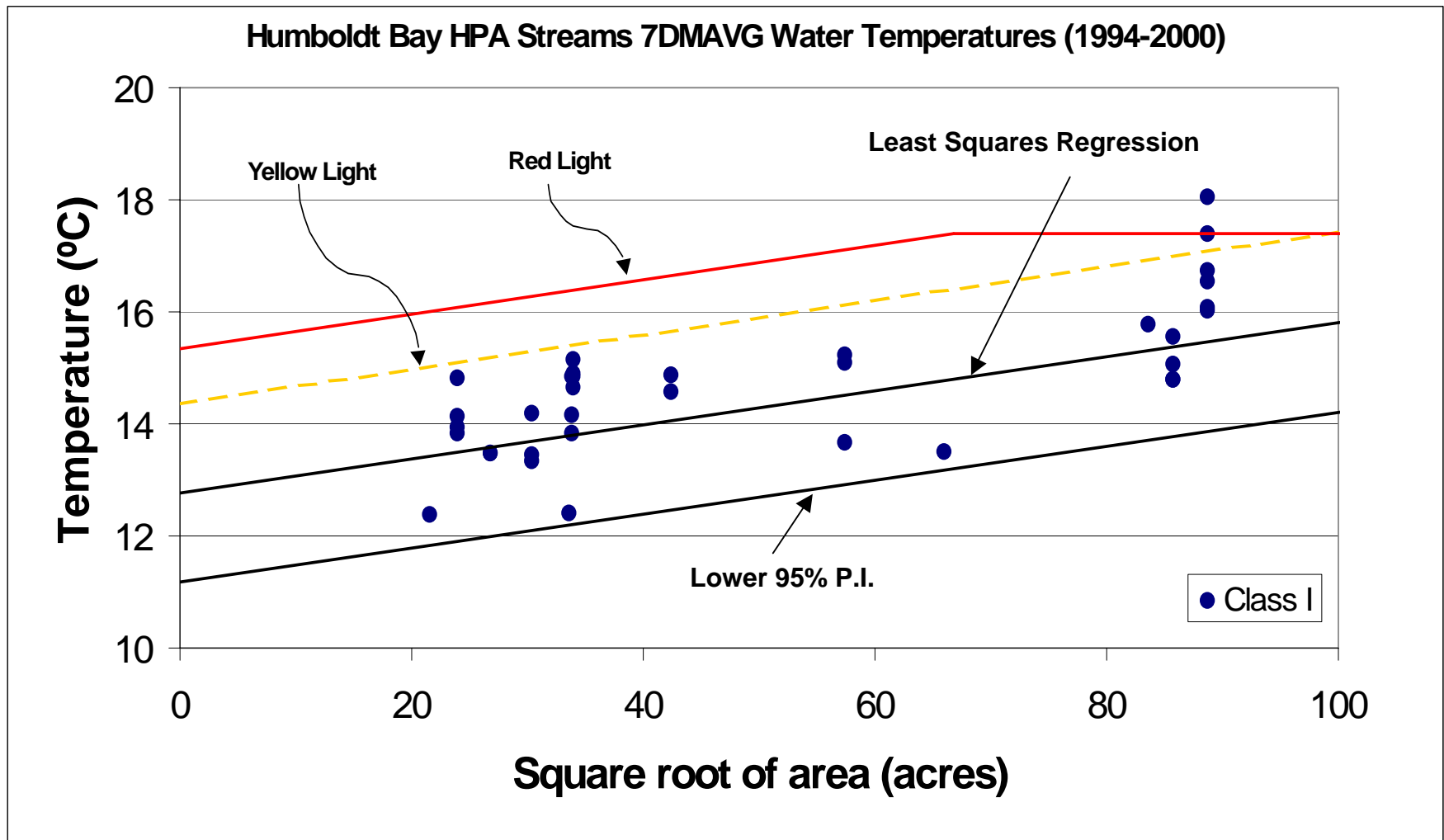


Figure 4-44. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Humboldt Bay HPA monitored between 1994 and 2000.

#### 4.4.10.6.2 Channel and Habitat Typing

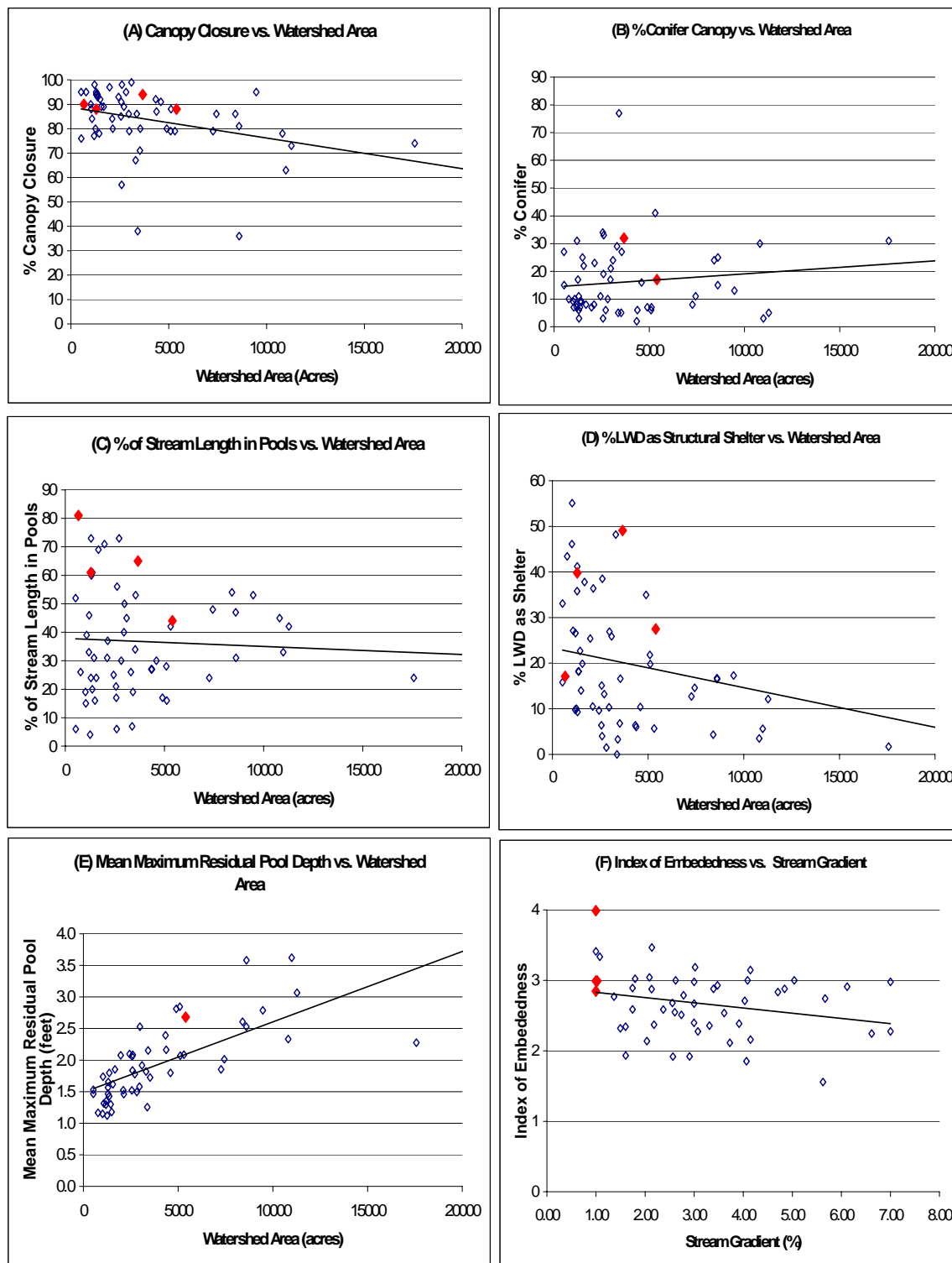
Four creeks have been assessed within the Humboldt Bay HPA (see Appendix C1 for details and Table C1-8 for summary of data collected):

<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
Ryan Creek	3,669 acres	1.0%
Salmon Creek	3,372 acres	1.0%
Ryan Creek Tributary 2	1,293 acres	1.0%
Ryan Creek Tributary 1	662 acres	1.0%

Ryan Creek and its 2 tributaries were assessed by California Conservation Corps (CCC) crews in 1995 and Salmon Creek was assessed by Green Diamond in 1994. The results of the channel and habitat typing surveys are summarized below and depicted in Figure 4-45 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and is not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

The results for the four assessed streams indicate the following:

- Percentage canopy closure for the four streams (88 to 94%) is somewhat above average compared with all other assessed streams (Figure 4-45 [A]).
- Only Ryan and Salmon creeks were assessed for percentage conifer canopy. Of the two, Ryan Creek had a rather large percentage of conifer (32%) and Salmon Creek had a rather typical percentage of conifer canopy (17%) compared with other assessed streams with similar watershed areas (Figure 4-45 [B]).
- Percentage of stream length in pools for the four streams varies widely (44-81%) but is generally higher than for other assessed streams regardless of watershed area (Figure 4-45 [C]).
- Percentage of LWD as structural cover for the four streams varies widely (17.1 to 49.1%) and, except for the first Ryan Creek tributary, generally is greater than that for assessed streams with similar watershed areas. (Figure 4-45 [D]).
- As shown in Figure 4-45 [E]) the average residual pool depth was determined only in Salmon Creek in this HPA. The data indicate that average residual pool depth in this stream (2.7 feet) is greater than most other assessed streams of similar watershed area.
- Pool tail-out embeddedness index values for the assessed streams in this HPA are very high (range = 2.89 to 3.99 on a scale of 4.0). The assessed streams are among those with the lowest gradient (Figure 4-45 [F]).



**Figure 4-45.** Channel and habitat types in four streams assessed in the Humboldt Bay HPA. (Solid diamonds are assessed streams in Humboldt Bay HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

In summary, these results suggest that the habitat within the assessed streams in the Humboldt Bay HPA is in many instances similar to other assessed streams of similar watershed area. There are, however, some habitat differences. The four streams on average have a higher percentage of canopy cover than many of the other assessed streams. The four assessed streams show considerable variation in their percentage LWD as structural shelter in pools and lengths of pools as a percentage of total stream length.

#### 4.4.10.6.3 LWD Inventory

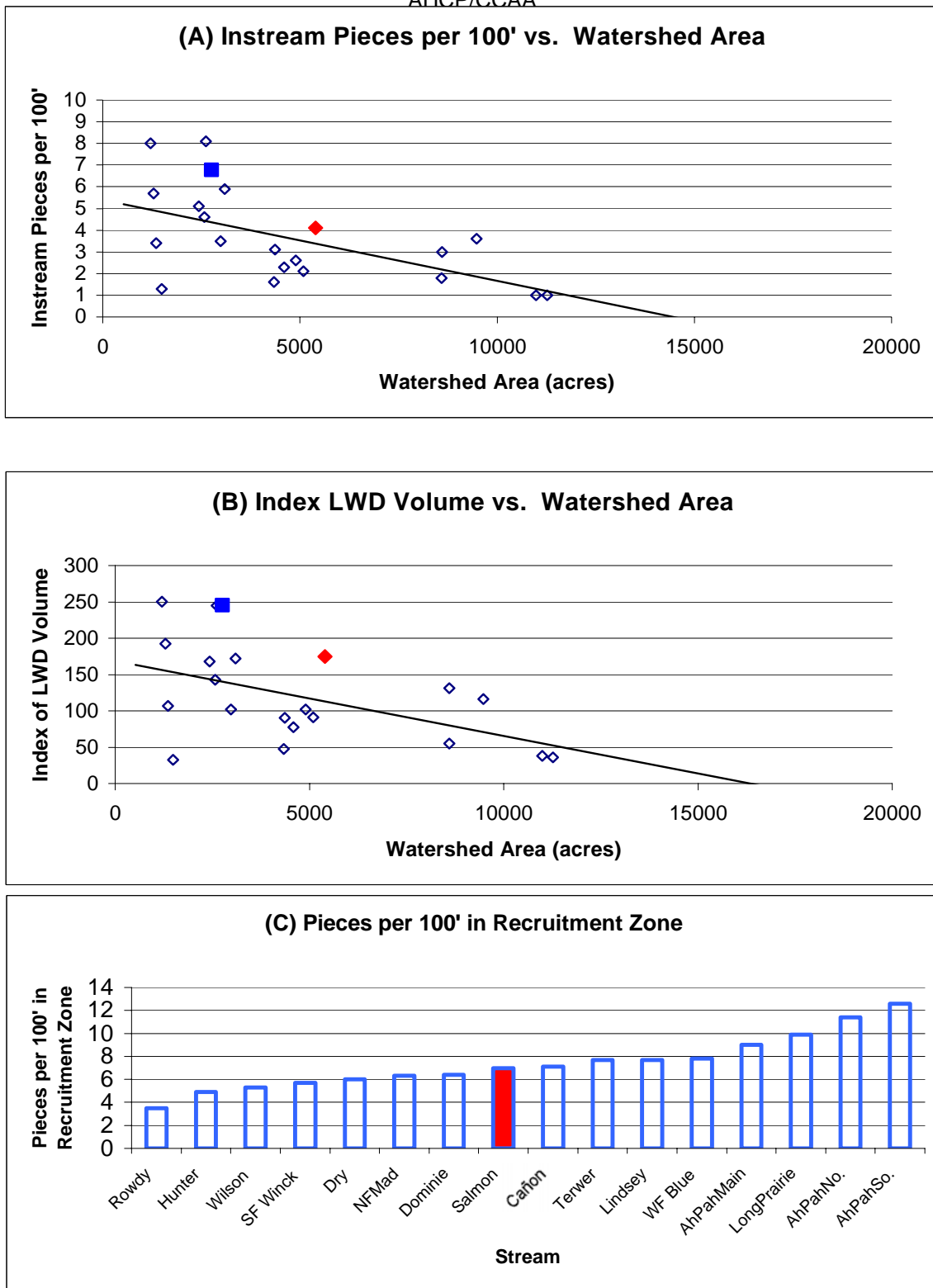
LWD survey/inventories were conducted only in Salmon Creek in the Humboldt Bay HPA (see Appendix C2 for details and Tables C2-7 and C2-14 for summary data). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD.

The results of these investigations are summarized below and presented in Figure 4-46 (A-B).

- As shown in Figure 4-46 (A), the average count of in-stream LWD pieces per 100 feet of channel for Salmon Creek (4.1 pieces) was greater than that for any assessed stream of similar watershed area but less than 60% of the average for Prairie Creek (6.8).
- The LWD volume index in Salmon Creek is greater than that for other assessed streams with similar watershed areas (Figure 4-46 [B]). The average number of pieces per 100 feet of riparian recruitment zone for Salmon Creek (7.0) is typical of the other assessed streams (Figure 4-46 [C]).

#### 4.4.10.6.4 Long-term Channel Monitoring

The monitoring objectives and methods for long-term channel monitoring in the Humboldt Bay HPA are presented in Appendix C3. The primary watersheds of concern are Salmon Creek and Jacoby Creek, both tributaries to Humboldt Bay. The Salmon Creek watershed was of concern due to its highly unstable and erosive geology (Wildcat Formation) and past management practices. Using the information from pilot studies that began in 1993, a revised methodology was developed and first implemented on reaches of Salmon Creek (a Humboldt Bay tributary) in 1996. These surveys have continued with scheduled re-surveys every two years or after a five year flood event. Data collected at the monitoring sites are scheduled for analysis in 2003. Each monitoring reach should have at least 3 years of data prior to the first analysis and be updated biennially to coincide with the biennial report to the Services that will be prepared under this Plan. No conclusions can be drawn at this point in the monitoring program.



**Figure 4-46.** LWD survey results for one stream assessed in the Humboldt Bay HPA. (Solid diamond is the assessed streams in Humboldt Bay HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)

#### **4.4.10.6.5 Estuarine Conditions**

The estuaries of Humboldt Bay's watersheds have been vastly altered over the past century. Residential and agricultural development associated with early timber harvesting from the surrounding slopes of the bay greatly impacted watershed estuaries. Extensive areas of highly productive wetlands were converted to pasture and residential land through a complex series of dikes, tide gates and levees. The lower section of Salmon Creek was channelized to maximize the amount of available pastureland. The tide gate on Salmon Creek has been suspected as being impassable by adult and juvenile salmonids on a wide range of flows. Recently, a section of the lower channel (now a National Wildlife Refuge) was reconstructed to its natural meander and the tide gate was modified to improve fish passage.

#### **4.4.10.7 Salmonid Population Estimates**

No salmonid population estimates have been conducted for streams in the Humboldt Bay HPA, and only limited spawning surveys have been conducted in Salmon Creek to date.

##### **4.4.10.7.1 Spawner Escapement Surveys**

Spawner surveys were conducted in Salmon Creek during 1998-9. Only seven unidentified redds were identified during one survey conducted during January 1999. Limited winter access into the watershed and visibility generally prevents effective survey coverage of the stream. Also, near the mouth of Salmon Creek, a tide gate may limit salmonid migration into the watershed.

#### **4.4.10.8 Covered Species Occurrence and Status**

Presence/absence of the Covered Species in the Humboldt Bay HPA is presented by drainage in Table 4-13, and the recorded distribution of the species is displayed in **Figure 4-47**.

##### **4.4.10.8.1 Chinook Salmon**

The Humboldt Bay HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA in September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the decision to list this ESU as threatened (64 FR 50405).

Drainages within the Humboldt Bay HPA are typically small, with no larger rivers, which are not typically preferred by chinook salmon. Chinook populations within this HPA are thought to be low, and while historical estimates are not available for comparison, the small size of the Humboldt Bay drainages makes it unlikely that this HPA was ever a significant producer of chinook.

**Table 4-13. Covered Species distribution in the Humboldt Bay HPA.**

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Humboldt Bay	3	3	3	3	3	3
Janes Creek	U	1	U	2*	U	U
Jolly Giant Creek	U	1	U	2*	U	U
Jacoby Creek	2	1,2,3	2,3	2	P	3
Washington Gulch	U	2	2,3	2	A	A
Morrison Gulch	P	2,3	2	U	A	A
Rocky Gulch	U	1	2	2*	3	U
Cochran Creek	U	1,2	2	2	U	U
Freshwater Creek	2	1	2	2	U	U
Ryan Creek	U	1,2,3	2,3	2,3	A	A
Henderson	U	1,3	3	3	A	A
Guptil	U	1,3	U	3	A	A
Bear	U	P	?	3	A	A
Cloney Gulch	U	1,2,3	2	2	U	U
Elk River	2	1,2,3	2	2	U	U
McCloud Creek	U	U	U	U	A	A
Salmon Creek	2,3	1,2,3	2,3	2	3	3
Little Salmon Creek	A	A	U	U	A	A
<b>Codes</b> U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT= resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records						

#### 4.4.10.8.2 Coho Salmon

The Humboldt Bay HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA in May 1997 (62 FR 24588). Coho populations are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

Coho have been documented in almost all of the drainages feeding Humboldt Bay (see Table 4-13). Information on abundance in these creeks is limited. As with the ESU as a whole, current numbers are depressed compared with historical estimates (Weitkamp et al. 1995).

#### 4.4.10.8.3 Steelhead and Resident Rainbow Trout

The Humboldt Bay HPA is within the Northern California Steelhead DPS, which was listed as threatened on May 7, 2000 (65 FR 36074). Steelhead abundance data are limited for this DPS, but available data indicate that winter-run populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby et al. 1996). The presence/absence data presented in

Table 4-14 represent the extent of current biological information on steelhead in this HPA.

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.10.8.4 Coastal Cutthroat Trout

Cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Gerstung (1998) reports that low numbers of coastal cutthroat have been reported in most tributaries where other salmonids are present, while much higher numbers have been observed in tributaries or headwaters of tributaries where no other salmonids are present. Current populations are thought to be depressed relative to historic levels (Gerstung 1997). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### 4.4.10.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in two streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Humboldt Bay HPA, tailed frogs were found in 1 of 2 sampled streams. In addition, tailed frogs have been found only in 3 other streams in the HPA as the result of incidental observations.

A relatively small portion (12.7%) of the HPA is in Green Diamond's ownership, so it is difficult to extrapolate from Green Diamond's studies to this HPA. However, much of this HPA is located within young unconsolidated geologic formations, which have been shown to have a strong negative influence on tailed frog occurrence due to a lack of suitable stream substrate in these geologic formations (Diller and Wallace 1999). Therefore, Green Diamond concludes that most streams in the Humboldt Bay HPA are most likely not suitable for tailed frogs and have no potential to become suitable outside a geologic timeframe.

#### 4.4.10.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in three streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Humboldt Bay HPA, none of the three sampled had southern torrent salamanders. In addition, southern torrent salamanders have been found only in 3 other streams throughout the HPA as the result of incidental observations.

A relatively small portion (12.7%) of the HPA is in Green Diamond's ownership, so it is difficult to extrapolate from Green Diamond's studies to the entire HPA. However, much

of this HPA is located within young unconsolidated geologic formations, which have been shown to have a strong negative influence on torrent salamander occurrence due to a lack of suitable stream substrate in these geologic formations (Diller and Wallace 1996). Therefore, Green Diamond concludes that most streams in the Humboldt Bay HPA are most likely not suitable for torrent salamanders and have no potential to become suitable outside a geologic timeframe.

#### **4.4.10.9 Assessment Summary**

The Humboldt Bay HPA has a coastal influence and most streams on the Original Assessed Ownership have high canopy closure, so it is expected that water temperatures in the streams should be cool. The lower reaches of Salmon Creek were an exception to this in 1997 and 1998, probably because of high flows in the winter of 1996/97 that reduced streamside vegetation. Much of the HPA is composed of weakly consolidated geologic parent material. As a result, most streams on the Original Assessed Ownership have relatively high levels of sediment inputs with high levels of fine sediments. The amount of LWD in the assessed streams in this HPA is generally good and has created more abundant and better quality pool habitat than that found in assessed streams in the other HPAs.

The salmonid Covered Species are relatively common in the Original Assessed Ownership in this HPA, and qualitative assessments indicate that many of these streams support relatively high numbers of juvenile salmonids. (Tannic waters of most of these low gradient streams preclude application of standard field protocols to allow quantification of their numbers.) The apparent high numbers of salmonids despite high levels of fine sediment inputs suggests that spawning habitat is not limiting even though suitable spawning gravels appear to be scarce in many of these streams. Presumably high juvenile survival due to abundant pool habitat with LWD for cover offsets limited spawning opportunities. In contrast to the salmonids, the amphibian Covered Species are generally absent in habitat on the Original Assessed Ownership in this HPA. This is consistent with the strong relationship between streams in weakly consolidated geologic units with excessive fine sediments and the lack of headwater amphibian species. In addition, there are few Class II watercourses on the Original Assessed Ownership with perennial flow in the areas with young unconsolidated parent material.

Given that there is little potential habitat for the amphibian Covered Species, the primary conservation effort for the Plan Area in the Humboldt Bay HPA should be to minimize mass wasting events that have the potential to aggrade the lower reaches and fill pool habitat. The greatest management-related benefits would likely come from addressing legacy roads in the riparian areas that have the potential to deliver large amounts of sediment with little or no LWD inputs.

#### **4.4.11 Eel River HPA**

##### **4.4.11.1 HPA Type, Size, and Group**

The Eel River HPA is a hydrographic area as defined in this Plan and is part of the Humboldt Bay HPA Group. It includes approximately 205,160 acres.

#### **4.4.11.2 Eligible Plan Area**

The Eligible Plan Area in the Eel River HPA includes approximately 86,026 acres: 7,933 acres of Initial Plan Area and 86,026 acres of Adjustment Area (see **Figure 1-2** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

#### **4.4.11.3 Geology**

The Eel River HPA is within the Coast Ranges Province (see **Figure 4-1**). Quaternary–Tertiary overlap deposits and Quaternary age alluvium with Coastal Belt Franciscan Complex bedrock occur near the southern boundary of the HPA, and Yager Terrane and Central Belt Franciscan bedrock underlie the eastern third of the area. Coastal Belt Franciscan bedrock underlies a very small area of the area at the south end of the HPA. The geologic structure of the area follows the northwest trend of regional geologic structure. The Little Salmon Fault, which is known to be presently active, passes through this HPA. The Freshwater Fault juxtaposes the Yager Terrane and Central Belt Franciscan bedrock and the Ferndale Fault roughly defines the trace of the Van Duzen River at its confluence with the Eel River. Topography within the Quaternary–Tertiary overlap deposits is highly variable and includes some steep slope segments. A maximum of a few hundred feet of relief exists within any of the five blocks of the area. Published and unpublished landslide maps indicate that both shallow and deep-seated landslides exist within this HPA.

#### **4.4.11.4 Climate**

Like the majority of Northern California, wet winters and dry summers characterize the Eel River basin. Nearly 80% of the annual precipitation falls between November and April. The average annual precipitation varies from less than 40 inches in the Eel River Plain and Round Valley to over 110 inches in the Bull Creek headwaters. The average annual precipitation for the entire Eel River basin is about 60 inches. Fog drip during the summer months is a source of precipitation not included in annual totals. The dense, often persistent, band of marine fog usually extends 20 to 30 miles inland. Measurements in the Bear River Ridge revealed fog drip accumulations of 12 inches in open areas and 8.5 inches under forest canopy. The two largest floods on record in the Eel River basin occurred in 1955 and 1964. The 1955 event had an instantaneous peak discharge of 541,000 cfs at Scotia. During the 1964 flood the instantaneous peak discharge at Scotia was 752,000 cfs.

#### **4.4.11.5 Vegetation**

The Eel River HPA extends 27 miles inland and reaches an elevation of 3700 feet at Laqua Buttes, on the divide into the upstream portion of the Mad River HPA. Dune and salt marsh vegetation at the estuary give way to agricultural development that has occurred and throughout the extensive flood plain of the lower Eel and Van Duzen Rivers. Urban development has been restricted to a few small communities and a strip of residential development along Highway 36 in the lower Van Duzen. Above the alluvial plain, forest cover dominates, with the usual progression of redwood/Douglas fir forests near the coast to Douglas-fir and Douglas-fir/tanoak forests in the interior. Spruce is common on coastal faces and at the margins of the coastal plain; and minor amounts of grand fir, western red cedar, and western hemlock occur on lower slopes and in riparian

zones. Red alder dominates many riparian zones, and tanoak is the most common mid to upper slope hardwood. Other common hardwoods are California laurel (pepperwood), Pacific madrone, and California black oak. Extensive prairies become prevalent in the most inland portions of the HPA, dominating many south to west slopes and ridgetops. Nearly pure stands of California black oak commonly form a transition type between prairies and conifer forest.

#### **4.4.11.6 Current Habitat Conditions**

##### **4.4.11.6.1 Water Temperature**

Water temperature monitoring in streams on the Original Assessed Ownership in the Eel River HPA began in 1994 and is ongoing today (see Appendix C5). From 1994-2000, 12 summer temperature profiles were recorded at 5 sites within 5 Class I watercourses in the HPA. No Class II temperature sites have been monitored to date. Figure 4-48 displays the 7DMAVG water temperatures for each monitored site in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. Results for the monitoring period (1994-2000) indicate that one Class I site exceeded the red light threshold twice (Stevens Creek in 1999 and 2000) and one Class I site exceeded the yellow light threshold once (Wilson Creek in 1997).

##### **4.4.11.6.2 Channel and Habitat Typing**

Four creeks have been assessed within the Eel River HPA (see Appendix C1 for details and Table C1-8 for summary data):

<u>Stream</u>	<u>Mid-point Watershed Area</u>	<u>Mid-point Gradient</u>
West Fork Howe Creek	3,372 acres	7.0%
Stevens Creek	3,308 acres	3.3%
Howe Creek	2,594 acres	2.1%
Wilson Creek	1,250 acres	2.6%

Stevens and Wilson creeks were surveyed by CDFG in 1991, and Howe and West Fork Howe Creek were surveyed by CDFG in 1998. The results are summarized below and depicted in Figure 4-49 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and is not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

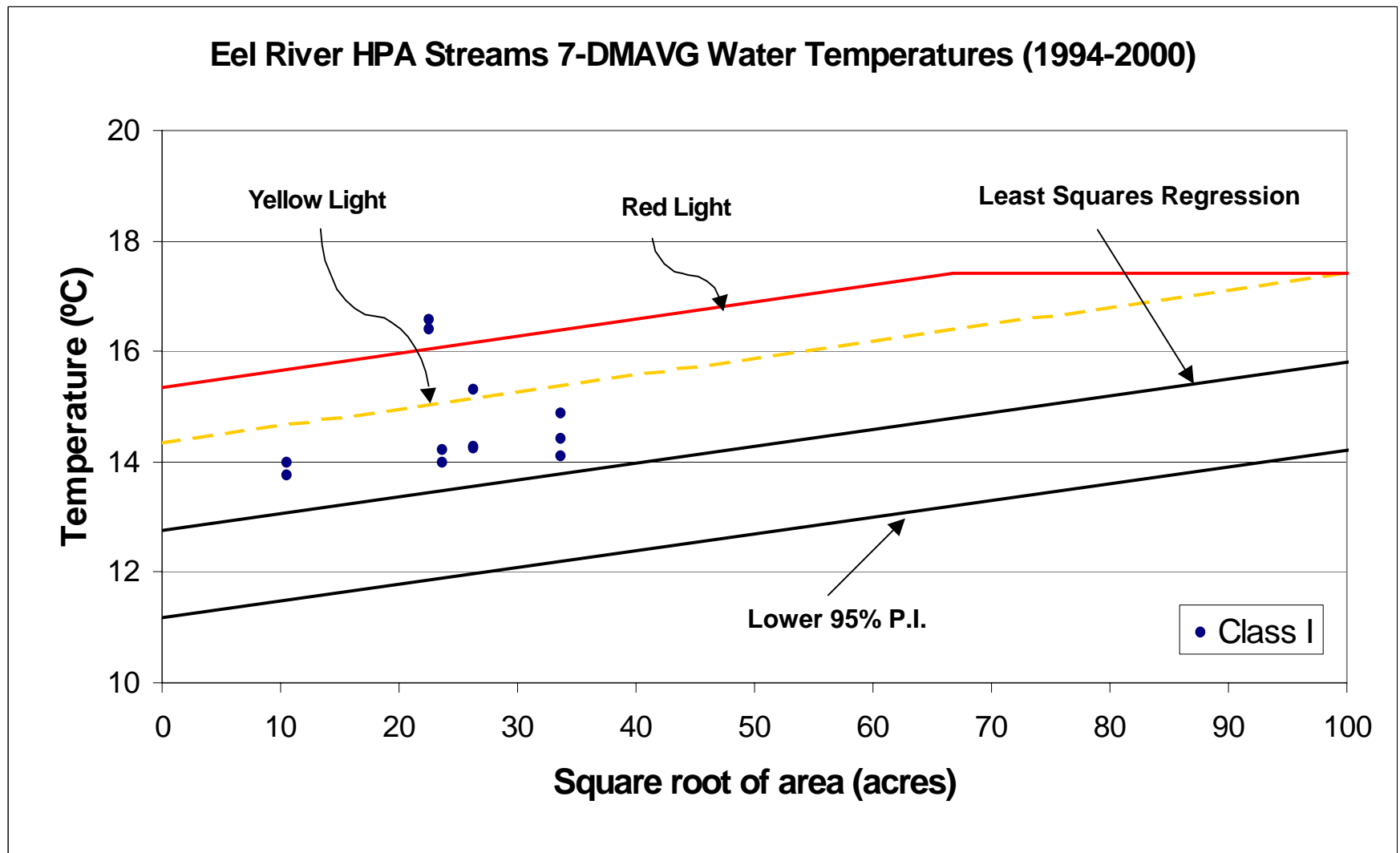


Figure 4-48. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Eel River HPA monitored between 1994 and 2000.

The results of the assessments indicate the following:

- Percentages of canopy closure for the streams ranges from 57% to 87% (Figure 4-49 [A]). Except for West Fork Howe Creek (87%), these percentages are somewhat below average compared with those for streams with similar watershed areas, except West Fork Creek. West Fork Howe Creek has a low percentage of conifer canopy (5%), indicating that the high percentage of canopy closure is from deciduous canopy (Figure 4-49 [B]).
- Three of the assessed streams have very low percentages of total stream length in pools (4-7%) compared to other assessed streams with similar watershed areas (Figure 4-49 [C]). The percentage for Stevens Creek 26% is typical of other assessed streams.
- The percentages of LWD as structural cover in pools for 3 of the 4 streams are some of the lowest for all assessed streams (Figure 4-49 [D]). For Howe, West Fork Howe, and Wilson creeks the percentage ranged from 0-10%. The percentage for Stevens Creek (48%) is relatively high.
- As shown in Figure 4-49 [E], the average residual pool depths in Wilson Creek and West Fork Howe are very low (1.1 to 1.3 feet) compared to streams with similar watershed areas. Pool tail-out embeddedness index values for Wilson and Stevens creeks also are comparatively low (Figure 4-49 [F]).

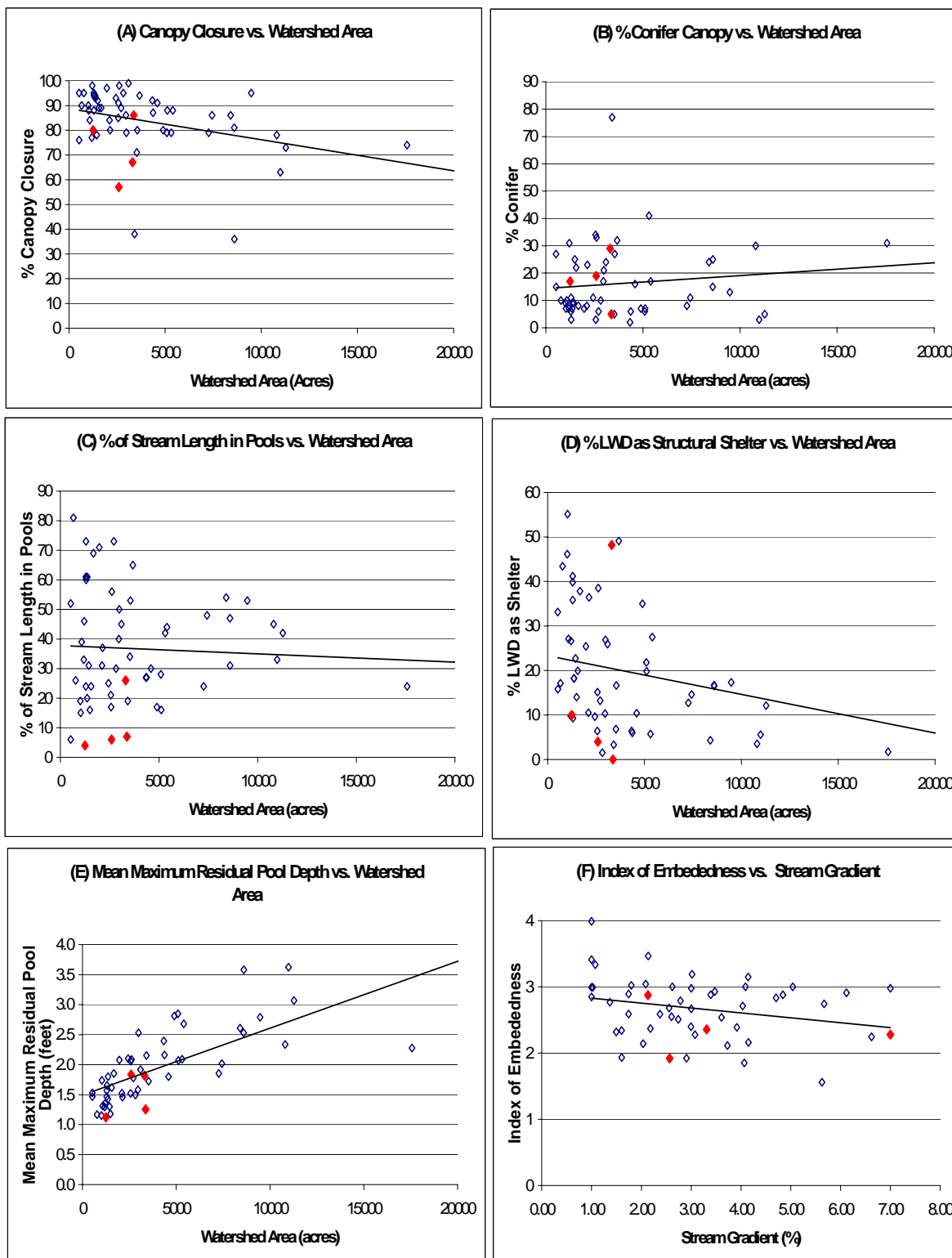
In summary, these results suggest that the habitat within the surveyed streams in this HPA is in many instances similar to that in other assessed streams of similar watershed area. On average, the assessed stream in this HPA have a comparatively low percentage of canopy cover, very low percentages of total pool length, low percentages of pool LWD cover, and low average residual pool depths.

#### **4.4.11.6.3 Estuarine Conditions**

The lower Eel River has lost valuable fisheries habitat through human activities. Wetlands, secondary channels, and sloughs have been impacted through extensive diking and channelizing. The original floodplain is now used for residential and agricultural purposes, mainly grazing of dairy cattle. Sediment deposits transported from upstream areas have turned once deep pools into shallow runs that offer marginal habitat to juvenile salmonids. The lower channel was also cleared of LWD jams for navigational purposes.

#### **4.4.11.7 Salmonid Population Estimates**

There were no salmonid population surveys in the Initial Plan Area of this HPA.



**Figure 4-49.** Channel and habitat types in four streams assessed in the Eel River HPA. (Solid diamonds are assessed streams in Eel River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

#### 4.4.11.8 Covered Species Occurrence and Status

Presence/absence of the Covered Species in Eel River HPA is presented by drainage in Table 4-14 and displayed in **Figure 4-50**.

**Table 4-14. Covered Species distribution in the Eel River HPA.**

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Eel River						
Palmer Creek	U	1	U	U	U	U
Rohner Creek	A	1	U	U	A	A
Van Duzen River	2	1	2	A	U	U
Yager Creek	2	1	2,3	A	U	U
Wilson Creek	A	1	2,3	A	U	U
Cuddeback Creek	A	1	2	A	U	U
Cummings Creek	2	1,2	2	A	U	U
Fielder Creek	2	1,A	2,3	A	U	U
Grizzly Creek	2	1	2	A	U	U
Stephens Creek	2	1,2	2,3	A	U	U
Fish Creek	U	U	2	A	U	U
Howe Creek	2	1,2	2	A	U	U
West Fork Howe	U	U	U	A	U	U
Slater Creek	A	A	A	A	A	A
<b>Codes</b> U= Unknown (no data available) P= Presumed present based on anecdotal information A= Presumed absent based on anecdotal information RRT= resident rainbow trout *= Occurrence of RRT assumed possible in streams where steelhead occur 1= Present based on NMFS records as of 2001 2= Present based on CDFG Region 1 files 3= Present based on Green Diamond records						

##### 4.4.11.8.1 Chinook Salmon

The Eel River HPA is within the California Coastal Chinook ESU, which was listed as threatened under the ESA as of September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the decision to list this ESU as threatened (64 FR 50405).

Information specific to Green Diamond's ownership or the Eel River HPA as a whole is limited to the presence/absence data shown in Table 4-14. Available abundance trends represent the Eel River drainage as a whole. Peak index counts and carcass surveys in two tributaries to the Eel River have shown precipitous long term declines since the 1960s, with recent increases in one tributary. Similar monitoring in other tributaries conducted since the late 1980s also have shown steep declines. The spring-run chinook in the upper Eel are possibly extinct, representing a significant loss of life history diversity in this ESU as a whole (64 FR 50405).

#### 4.4.11.8.2 Coho Salmon

The Eel River HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA in May 1997 (62 FR 24588). Coho populations are depressed throughout the ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

Specific information on coho abundance within the Eel River HPA is limited to the presence/absence data in Table 4-14. The abundance of introduced Sacramento pikeminnows in the Eel River is a cause for concern. Coho abundance in the Eel River, as in the rest of the ESU, is depressed (Weitkamp et al. 1995).

#### 4.4.11.8.3 Steelhead and Resident Rainbow Trout

The Eel River HPA includes the Northern California Steelhead DPS, which was listed as threatened on June 7, 2000 (65 FR 36074). Steelhead abundance data are limited for this DPS, but available data indicate that winter run populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby et al. 1996). Nehlsen et al. (1991) identified summer steelhead in the Eel River as at risk of extinction, although the Little Van Duzen River winter steelhead stock was identified as stable in further analysis by Higgins et al. (1992). Counts at Eel River dams in the 1930s and 40s averaged 4,400 adult steelhead annually at Cape Horn Dam and 19,000 adult steelhead annually at the Benbow Dam. Recent counts at Cape Horn Dam average 115 adults, of which only 30 are native fish. In addition to these declining trends, the abundance of the introduced Sacramento pikeminnow and sedimentation are some of the main concerns cited for steelhead in the Eel River (Busby et al. 1996).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

#### 4.4.11.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout are found in one tributary to the lower Eel (Strong's Creek), one tributary to the Van Duzen (Fox Creek), and a few small streams that flow into the Salt River Slough (Gerstung, 1997). Green Diamond currently has no ownership in the drainages of these tributaries. When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

#### 4.4.11.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in two streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Eel River HPA, no tailed frogs were found in either of the two sampled streams. In addition, no tailed frogs have been found in other streams throughout the HPA as the result of incidental observations.

A very small portion (3.9%) of the HPA is in Green Diamond ownership, so it is not possible to extrapolate from Green Diamond's studies to the entire HPA. However, much of this HPA is located within young unconsolidated geologic formations, which have been shown to have a strong negative influence on tailed frog occurrence due to a lack of suitable stream substrate in these geologic formations (Diller and Wallace 1999). Therefore, Green Diamond concludes that most streams in the Eel River HPA are most likely not suitable for tailed frogs and have no potential to become suitable outside a geologic timeframe.

#### **4.4.11.8.6 Southern Torrent Salamander**

Green Diamond conducted presence/absence surveys for southern torrent salamanders in one stream in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Eel River HPA, no southern torrent salamanders were found in the one sampled stream. In addition, no torrent salamanders have been found in other streams throughout the HPA as the result of incidental observations.

A very small portion (3.9%) of the HPA is in Green Diamond's ownership, so it is not possible to extrapolate from Green Diamond's studies to the entire HPA. However, much of this HPA is located within young unconsolidated geologic formations, which have been shown to have a strong negative influence on torrent salamander occurrence due to a lack of suitable stream substrate in these geologic formations (Diller and Wallace 1996). Therefore, Green Diamond concludes that most streams in the Eel River HPA are most likely not suitable for torrent salamanders and have no potential to become suitable outside a geologic timeframe.

#### **4.4.11.9 Assessment Summary**

Little work has been done to assess streams in the Eel River HPA because the Original Assessed Ownership constitutes a very small portion (4%) of the HPA and does not include any major Class I watercourses. Available data indicate that the streams on the ownership in this HPA tend to have lower canopy closure compared to assessed streams in other HPAs. Like several other HPAs, the Eel River HPA is generally located in the coastal region. However, there is a north-to-south gradient that causes this southernmost HPA to experience relatively high summer temperatures. As a result, all of the recorded water temperatures for streams on the Original Assessed Ownership are above the trend line in the regression of water temperature on drainage area and several are above the red and yellow-light threshold. Most of the Original Assessed Ownership in this HPA is underlain by weakly consolidated geologic parent material and as a result, most of the streams have relatively high levels of sediment inputs with high levels of fine sediments. The amount of LWD is generally low, and there is relatively little pool habitat compared to that in assessed streams in most HPAs.

The salmonid Covered Species are generally scarce in the streams of the Original Assessed Ownership in this HPA. This is probably a combination of most of the streams being quite small and generally in poor condition. The amphibian Covered Species appear to be completely absent in habitat on the Original Assessed Ownership in this HPA. This is consistent with the strong relationship between streams in unconsolidated

geologic regions with excessive fine sediments and a lack of headwater amphibian species.

Given that there is little potential habitat for the salmonid Covered Species and no habitat for the amphibians, the Plan Area in the Eel River HPA should be to the lowest priority for conservation efforts. Any future conservation activities initiated in the Plan Area of this HPA would probably be best focused on addressing legacy roads in riparian areas that have the potential to deliver sediment with little or no LWD inputs.